Forest Inventory and Monitoring Program: Growth and Yield Standards and Procedures

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Preface

The standards and procedures described in this chapter of *the Forest Inventory Manual (Volume 3 – Growth and Yield/ Decay and Volume)* are based upon the *Minimum Standards for the Establishment and Remeasurement of Permanent Sample Plots in British Columbia.*

The latter publication was developed for the Forest Productivity Council (FPC) to recommend minimum standards for measurement of permanent sample plots for the purpose of measuring growth and estimating future yield. It was last revised in March 1999. See the following website for further information: http://srmwww.gov.bc.ca/forestproductivity/ .

With the inactivity of the FPC, the Ministry of Sustainable Resource Management (previously Ministry of Forests) continues to upgrade the *Forest Inventory Manual* in response to client needs. The chapter following reflects that updated methodology and supersedes the FPC Minimum Standards document. The Ministry of Sustainable Resource Management recommends that this methodology be followed for all establishments and remeasurements of permanent sample plots.

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The Government of British Columbia provides funding of the Resources Information Standards Committee work, including the preparation of this document. The Resources Information Standards Committee supports the effective, timely and integrated use of land and resource information for planning and decision making by developing and delivering focussed, cost-effective, common provincial standards and procedures for information collection, management and analysis. Representatives to the Committee and its Task Forces are drawn from the ministries and agencies of the Canadian and the British Columbia governments, including academic, industry and First Nations involvement.

The Resources Information Standards Committee evolved from the Resources Inventory Committee which received funding from the Canada-British Columbia Partnership Agreement of Forest Resource Development (FRDA II), the Corporate Resource Inventory Initiative (CRII) and by Forest Renewal BC (FRBC), and addressed concerns of the 1991 Forest Resources Commission.

For further information about the Resources Information Standards Committee, please access the RISC website at: http://srmwww.gov.bc.ca/risc/.

Table of Contents

Preface ... iii

Acknowledgments ... v

1. Establishing Permanent Sample Plots in Natural Stands ... 1

Introduction ... 1

Field Training ... 1

Selecting Natural Stands ... 1

Unsuitable Areas ... 2

Locating and Marking Permanent Natural Samples ... 2

Describing Access and Location of the Sample ... 2

Choosing a Tie Point ... 3

Running a Tie Line from the Tie Point ... 3

Marking the Plot Centre ... 3

Establishing Plots ... 4

Choosing the Plot Size ... 4

Marking the Plot Circumference ... 5

Dividing the Plot into Sectors ... 5

Tagging Trees ... 6

Establishing Sub-plots ... 7

Choosing the Sub-plot Size ... 7

Dividing the Sub-plot into Sectors ... 7

Tagging Trees in the Sub-plot ... 8

Gathering Data About the Sample ... 8

Measuring the Trees ... 9

Classifying Trees ... 9

Pathological Indicators ... 11

Dead Tree Attributes ... 12

Assessing Damage Agents and Severity ... 12

Assigning a Crown Class Code ... 12

Estimating Live-crown Length ... 13

Recording Stumps 13
Determining the Stand Structure 13
Height Sample Trees 14
Estimating Other Plot Attributes 17
Stem Mapping 18
Collecting Ecological Data 19
Quality Assurance 19
Inspecting the Samples 20
Mapping Samples 21
Submitting the Samples 22
Once the samples are checked in the office and corrected: 22
2. Remeasurement of Permanent Sample Plots in Natural Stands 23
Introduction 23
Preparing for Field Work 23
Field Training 23
Relocating the Plot 23
Checking Location and Access 23
Checking the Tie Line 24
Checking the Centre Tree 24
Checking the Plot Centre Tree Markers 25
Checking the Plot Centre Stake 25
Remeasuring the Plot and Sub-plot 26
Converting Breast Height in Industrial Permanent Samples 26
Sectors in the Plot 26
Tagging Trees 26
Measuring DBH 27
Classifying Trees 28
Pathological Indicators 30
Assessing Damage Agents and Severity 30
Assigning a Crown Class Code 31
Estimating Live-crown Length 31

    Tagging Ingrowth Trees 32
    Recording Data About the Sample: 32
    Sub-plot and Tree Count 33
    Measuring Sub-plot Trees 33
    Determining the Stand Structure 34
    Height Sample Trees 35
    Estimating Other Plot Attributes 38
  Stem Mapping 39
  Collecting Ecological Data 40
  Quality Assurance 40
    Inspecting the Sample 41
  Damage to the Sample and Returning the Samples 43
    Damage to the Sample 43
    Returning the Samples 43
3. Remeasuring Experimental Plots in Natural Stands 45
  Introduction 45
  Preparing for Field Work 45
    Field Training 45
  Relocating the Plot 46
    Checking Location and Access 46
    Checking the Tie Line 47
    Checking Corner Posts and Centre Stake 47
  Remeasuring the Plot and Sub-plot 47
    Converting the Breast Height in Experimental Permanent Samples 47
    Sectors in the Plot 47
    Tagging Trees 48
    Measuring DBH 48
    Classifying Trees 49
    Pathological Indicators 51
    Assessing Damage Agents and Severity 51
    Assigning a Crown Class Code 52
    Estimating Live-crown Length 52

Tagging Ingrowth Trees ... 53
Recording Data About the Sample: ... 53
Sub-plot and Tree Count ... 54
Determining the Stand Structure ... 56
Height Sample Trees ... 56
Estimating Other Plot Attributes ... 60
Collecting Ecological Data ... 60
Quality Assurance ... 61
Inspecting the Sample ... 61
Damage to the Sample and Returning the Samples ... 63
Damage to the Experimental Plot ... 63
Returning the Samples ... 63
4. Remeasurement of Permanent Sample Plots in Silviculturally Treated Stands ... 65
Introduction ... 65
Preparing for Field Work ... 65
Field Training ... 65
Relocating the Plot ... 65
Checking Location and Access ... 65
Checking the Tie Line ... 66
Checking the Centre Tree ... 66
Checking the Plot Centre Tree Markers ... 67
Checking the Plot Centre Stake ... 67
Remeasuring the Plot ... 68
Sectors in the Plot ... 68
Tagging Trees ... 68
Measuring DBH ... 69
Classifying Trees ... 69
Pathological Indicators ... 71
Assessing Damage Agents and Severity ... 72
Assigning a Crown Class Code ... 72
Estimating Live-crown Length ... 73
Tagging Ingrowth Trees ... 73

Remeasuring the Sub-plot 74
Determining the Stand Structure 75
Height Sample Trees 76
Estimating Other Plot Attributes 79
Stem Mapping 80
Quality Control, Damaged Samples and Returning Samples to Victoria 80
Inspecting the Sample 81
Damage to the Sample 83
Returning the Samples to Victoria 83
Appendix 1: Standards of Measurement for Permanent Samples 85
Appendix 2: Weighted Error Rating Table and the Basis for the Acceptance or Rejection of a Plot 87
Appendix 3: Species Symbols 89
Names and Symbols for Tree Species in B.C. 89
Appendix 4: Equipment List for Permanent Sample Measurements 93
Appendix 5: Tie Point and Plot Centre Aluminum Markers 95
Appendix 6: Plot and Sub-plot Radii Slope Allowance for Natural Stands Samples 97
Appendix 7: Isogonic and Isoporic Table 99
Magnetic Declination and Annual Change for May 2002 99
Appendix 8: Plot and Sub-Plot Radii Slope Allowance For Treated Stands 101
Appendix 9: Determining Breast Height 103
Appendix 10: Special Rules for the Measurement and Classification of Abnormal Trees 105
Counting and Height Measurement of Abnormal Trees Less than 2.0 cm DBH. 105
Distinction Between Broken Top and for Trees Greater than 2.0 cm DBH. 107
Trees Greater than 2.0 cm DBH Growing Along the Ground 107
Appendix 11: Pathological Classification of Trees 109
Classes of Trees 109
Suspect Trees 109
Residual Trees 110

Suspect Indicators of Decay on Standing Trees 110
  Conks 110
  Blind Conks 110
  Scars 111
  Fork or Pronounced Crook 116
  Frost Cracks 117
  Mistletoe Trunk Infections 118
  Rotten Branches 119
  Dead Top 119
  Broken Top 119
Non-suspect Abnormalities 120
  External Evidence of Butt Rot Not Associated With Suspect Abnormalities 120
  Flutes 120
  Candelabra Branches 120
  Branch Fans 121
  Black Knots 122
  Burls and Galls 122
  Sweep 123
  Exposed Roots 123
  Spiral Grain 123
  Dry Side 123
  Sapsucker Holes 124
  Insect Borings 124
Appendix 12: Crown Class 125
Appendix 13: Stand Structure 127
Single-layered Stand Structure 127
  Single-layered, simple structure without veterans 127
  Single-layered, simple structure with veterans 127
  Complex stand structure 128
  Complex stand structure with veterans 128
Multi-layer Stand Structure 129
Appendix 14: Damage Agents and Severity Codes 133

I. Damage Agents 133

II. Damage Severity and Mortality Condition Codes 139

Appendix 15: Quality Assurance Report 141

Appendix 16: Completing the Field Sheets 145

Appendix 17: Location and Access Notes Example 151

Appendix 18: Recommended Protection Buffers for Permanent Samples 153

Appendix 19: Growth Sample Record Sheet 155

Appendix 20: Guidelines for Deciding if Damaged Permanent Plots Should be Remeasured157

Appendix 21: Converting Breast Height in Industrial Permanent Samples 159

Method 1 159

Method 2 159

Establishing a Sub-plot in Industrial Plots 159

Appendix 22: Dead Tree Attributes 161

Appendix 23: Field Assessment of Suppressed Trees 163

Appendix 24: Example of Tagging and Site Sectors for Remeasuring Plots 165

Appendix 25: Minimum Data Collection Requirements for Ecological Field Forms (FS 882)167

Vegetation Form 168

1. Establishing Permanent Sample Plots in Natural Stands

Introduction

Permanent Samples are established in natural stands to measure:

1. rates of growth,
2. mortality,
3. change in stand structure, and
4. stand development.

The data collected is used to develop growth and yield models, validate site index curves, and to provide a basis for further scientific studies.

Stands are selected for sampling by means of a detailed analysis of previous surveys by management unit. Natural samples should not be established in multi-layered stands except in forest districts where this type of stand structure is prominent.

For a list of measurement standards see the "Standard of Measurement for Permanent Samples" in Appendix 1.

Established samples must be classified ecologically according to Research Branch specifications.

Since permanent samples are cost intensive, protecting them is of the utmost importance. Using buffers, as illustrated in "Recommended Protection Buffers for Permanent Samples" Appendix 18, is recommended.

Field Training

All personnel involved in establishing natural samples in the field should attend a short training course on field procedures. Next, crews should work under the direct guidance of senior personnel long enough to gain a full understanding of the different phases of the work and to become efficient at collecting field measurements.

Selecting Natural Stands

1. Obtain the most recent forest cover maps and status maps and note the areas where you might establish a natural sample.
2. Select stands that meet the following matrix cell stratification criteria:
    - biogeoclimatic ecosystem classification (BEC) zone;
    - species group;
    - age class;
    - site index class;

- density class.

3. Collect the latest air photos of the areas.
4. Carry out field reconnaissance of the areas to ensure that:
   - the stands are relatively free of insects and disease;
   - the stands are relatively free of injury, such as animal damage, and windthrow;
   - the portions of the stands that will contain the plot and buffer are relatively homogeneous in species composition, age, aspect, density and height.
5. Discard unsuitable areas.
6. Assign a number to the selected samples. Consult the provincial sample list, which enumerates samples consecutively by region and compartment. Assign the next number available within the compartment. Do not assign the sample a number already in use.

Further details on selecting strata are agreed to by the regional Inventory Officer and by the Growth and Yield Section of the Resources Inventory Branch.

For a list of equipment used in establishing plots in natural stands, see the "Equipment List for Permanent Sample Measurements" in Appendix 4.

Unsuitable Areas

In even-aged forests, examples of unsuitable areas are:

1. stands containing more than fifty veterans per hectare;
2. stands that are too small to accommodate the plot and buffer;
3. stands that may be too old for at least three remeasurements.

In all-aged or residual forests, examples of unsuitable areas are:

1. stands too small to accommodate a sample and buffer.
2. stands in which site and species composition vary extremely.

Locating and Marking Permanent Natural Samples

Describing Access and Location of the Sample

For the benefit of future remeasurement crews, describe in detail how to get to the sample, and where it is located.

1. Start from an easily identifiable landmark that won't change during the ten years between measurements. **Examples**: a bridge crossing, a main road junction.
2. From the starting point, travel to the sample. En route, note the distances to road junctions, creek crossings, or other prominent features.
3. Describe the tie point. See "Choosing a Tie Point" in this chapter.
4. Describe the species, diameter and location of the tie tree. See "Choosing a Tie Point" in this chapter.

Choosing a Tie Point

1. Choose a tie point, or reference point. The tie point should be a permanent topographic feature distinguishable on air photos and on the ground. **Examples**: a road junction, a bend in the road, a creek junction, a road crossing, a creek.
2. Choose the tree closest to the tie point. This is your tie tree. Paint both sides of the tree approximately 2 m above the ground in the direction of the tie line.
3. Nail aluminum markers over the paint. The aluminum plot markers are designed to be used in all the growth and yield programs. Each marker is divided into three sections. See "Tie Point and Plot Centre Aluminum Markers" in Appendix 5.
4. Inscribe the following information in the middle and bottom sections of the markers:
    - the sample type (G for natural stands);
    - the sample number;
    - the plot number (always 1);
    - the region number;
    - the compartment number;
    - the bearing and distance to the plot;
    - the date the sample was established.
5. Mark the tie tree with two strands of plastic flagging tape, one above and one below the aluminum markers.
6. Prepare a sketch showing the tie point, sample location, and other significant topographic features, and attach it to the access notes.

Running a Tie Line from the Tie Point

Run the tie line from the tie point to the plot centre using a hand compass, a Suunto clinometer and a measuring tape.

1. On a set bearing, locate the boundary of the plot.
    - The plot boundary must be at least 50 m from the edge of the forest type represented by the plot. The exception is if the field officer does a written justification for decreasing the distance. Under no circumstances can this distance be less than the average height of the plot. This is the buffer.
2. Follow the bearing set on the hand compass for the required horizontal distance.
3. Measure the slope with the clinometer and make the required correction for horizontal distance.
4. Mark each side of the trees along the tie line with paint. As well, flag the tie line often enough to be readily followed.

Marking the Plot Centre

1. Mark the plot centre with a one-metre tubular aluminum stake, driven into the ground for at least half its length. This is the plot centre stake.
2. Build a cairn around the base of the stake to support it firmly.
3. For plots that will not be stem mapped, select three trees around the plot centre, and record the bearing, slope and distance from the plot centre stake to the centre of each tree. Place a nail at the centre of each tree for consistency in measuring distance to the centre

stake. This will help future measurement crews locate the position of a centre stake that has been pulled out.

4. Choose a large living tree close to the plot centre stake. This is the plot centre tree.
5. Nail two aluminum plot markers, in the direction of the tie line, to the plot centre tree about 2 m above the ground.
6. Record the following information in the top section of each aluminum marker:
   - sample type (G);
   - sample number;
   - plot number (always 1).
7. Record the following information in the bottom section of each aluminum marker:
   - region number;
   - compartment number;
   - date the sample was established.
8. If the plot centre is also the tie point for the next sample, fill out the middle section of the aluminum marker.
9. Flag the plot centre tree with two strands of flagging tape, one above and one below the aluminum markers.

Establishing Plots

A sample in a natural stand consists of one single circular plot. The radius of the plot is measured from the plot centre stake. All trees of measurable size inside the plot are then tagged. See "Tagging Trees" in this chapter.

Choosing the Plot Size

The objective of the sampling design is to obtain a sample of approximately 90 living commercial and non-commercial trees with a diameter at breast height (dbh) of 4 cm or greater.

The plot size may vary to accommodate different stand densities. In those forest districts with samples established in multi-layered stands, the plot size is selected based on the top layer.

Choose the plot size to fit the stand's density – open, basic, or dense. Here are the radius measurements to use:

Stand	Plot Size	Radius	Approx. Stems/ha
Open Stands	0.10 Ha	17.84 m	< 600
	0.09 ha	16.93 m	600 - 1000
Basic	0.08 ha	15.96m	1,000 – 1,500
Dense Stands	0.07 ha	14.93 m	1,500 – 2,000
	0.06 ha	13.82 m	2,000 – 3,000
	0.05 ha	12.62 m	3,000 – 5,000
	0.04 ha	11.28 m	5,000+

Dense Young Stands

In dense young stands, there may be few, if any, trees 4 cm dbh or greater. Using the maximum plot size would result in too many ingrowth trees of 4 cm dbh or greater in the future. For these stands, use the plot sizes 0.04 ha or 0.05 ha and ignore the minimum tree requirement. However, increase the sub-plot size to obtain a total of approximately 110 trees for the plot and sub-plot together. As a guide, for stands less than 41 years old with a density of 5,000 stems per hectare or greater, use the 0.04 ha plot size. For stands less than 41 years old with a density between 3,000 and 5,000 stems per hectare, use the 0.05 ha plot size.

Example: If the plot has only 34 trees 4 cm dbh or greater, make the sub-plot large enough to include 76 trees less than 4 cm dbh and at least 0.3 m in height.

For more information on sub-plots, see "Choosing the Sub-plot Size" in this chapter.

Marking the Plot Circumference

1. Using a plot tape, measure the chosen plot radius from the plot centre stake.
   - On level terrain, hold the tape horizontally;
   - On sloping terrain, hold the tape parallel to the slope, measure the slope with the clinometer using the percent scale, and apply a slope correction to the radius. See "Plot and Sub-plot Radii Slope Allowance for Natural Stands Samples" in Appendix 6.
2. Measure the plot radius a minimum of eight directions and mark the circumference with plot string.
3. Check trees close to the circumference with the plot tape. These trees are called line trees. Include line trees in the plot when at least half their base is inside the plot.

Dividing the Plot into Sectors

Divide the plot into pie-shaped, 0.01 ha sectors. These are the tagging and site sectors. For ease of tagging dense plots with areas of 0.04 and 0.05 ha, divide the plot into 0.005 ha tagging sectors but combine them into pairs in order to have 0.01 site sectors. This procedure is needed to choose the correct number of site trees later.

Sector 1, in both cases, is always the first sector clockwise from north.

Tagging Trees

Once you divide the plot into sectors, tag all commercial and non-commercial trees that have a dbh of 4.0 cm and greater for living trees and 10.0 cm and greater for dead standing trees. Use round, blue plastic tags with white numbers from 1 to 300. Do not duplicate tag numbers in a plot.

Tagging by Sectors

1. Start with sector 1. In this sector, affix the tags so that they face the **plot centre**.
2. Tag the trees near the plot centre first; then continue tagging outward by moving side-to-side across the pie-shaped sector.
3. As you reach the circumference of sector 1, make the last sideways pass in the direction of sector 2 so that the last tree tagged in sector 1 is, as near as possible to the first tree you will tag in sector 2.
4. Begin tagging sector 2. In this sector, affix the tags so that they face the **circumference**, not the plot centre as in sector 1.
5. Tag the trees near the circumference first, then continue tagging inward by moving side-to-side across the pie-shaped sector.
6. Make sure the last tree you tag in this sector is the one closest to the plot centre.
7. Repeat the procedures used in sectors 1 and 2 for the remaining sectors. Remember that tags in odd-numbered sectors face the plot centre while those in even-numbered sectors face the circumference.

Attaching Tags to Trees

1. Affix tags at breast height, which is 1.3 metres above the base of the tree on the uphill side. Use a 1.3-metre long dbh stick to measure the correct height. See "Determining Breast Height" in Appendix 9.
2. If abnormal swelling or branch whorls occur at breast height, raise or lower the tag by up to 5 cm.
3. Nail the tag to the tree:
   - use 6 cm aluminum nails;
   - drive the nail slightly upward so the tag hangs away from the tree;
   - drive the nail into the trunk just enough to hold the tag securely and yet allow for radial growth.

Tagging Forked Trees

Here are special rules for tagging forked trees:

1. Tag the stem as a single tree if:
   - the fork occurs above 1.3 m, and
   - the stem has a dbh of at least 4 cm, (10.0 cm for dead trees).
2. Tag each stem separately if:
   - the fork occurs below 1.3 m, and
   - two or more of the fork's stems have a dbh of 4 cm or greater, (10.0 cm or greater for dead trees). Use consecutive numbers when you tag these stems.

3. Tag the stem as a single tree if:
    - the fork occurs below 1.3 m, and
    - only one of the fork's stems has a dbh of 4 cm or greater, (10.0 cm for dead trees).

Measuring the Diameter of Trees Growing Together

To more accurately measure the diameter of trees that are or will soon be joined together at dbh, use the "1/2 wrap" method. To do this, measure or estimate, as accurately as you can, the diameter of each affected tree. Then, from the nail with the tag, measure half of the diameter around the bole of the tree and place a second nail. Note in the remarks, that these are "1/2 wrap" measurements. In the future, the distance between the two nails will be measured and multiplied by two to arrive at the diameter of the tree.

Tagging Unusual Live Trees

Now and then you will find unusual live trees within a plot or sub-plot. **Example**: a tree of taggable size growing on a tall stump too high to climb. Exercise good judgment in these odd situations. Treat the above example like this:

1. Assign a tree number to the tree and attach the tag to the stump.
2. Estimate and record the diameter of the tree.
3. Note in the remarks, that you estimated the diameter.
4. Record any pathological indicators on the tree. See "Pathological Indicators" in this chapter.

Establishing Sub-plots

We establish sub-plots within a given plot to get some representation of trees smaller than the plot tagging limit, that is, trees less than 4 cm dbh. The objective is to obtain a sample of approximately 20 trees of commercial species that are less than 4 cm dbh and at least 0.3 m high.

Choosing the Sub-plot Size

Like the sample, the sub-sample consists of one circular sub-plot. Like the plot, the size of the sub-plot depends on the stand's density. The minimum acceptable size is 0.002 ha and the maximum is the plot size.

Choose the sub-plot size that will produce the desired number of trees. For a list of sub-plot sizes and radii, see Appendix 6.

Using the procedure described in "Marking the Plot Circumference" in this chapter, mark the sub-plot circumference with string.

Dividing the Sub-plot into Sectors

For the sub-plot, use the same sector divisions you laid out for the main plot.

Tagging Trees in the Sub-plot

What to Tag

Tag with nails all living trees of commercial species between 2 cm dbh and 3.9 cm dbh. For procedures, see "Tagging Trees" in this chapter.

For trees of commercial species less than 2 cm dbh:

1. Count them in a dot tally.
2. Derive their dbh classes (see table below).
3. Record them by species and dbh class.

Metric Dbh Classes and Limits

dbh class	Limits
0	0.3 m to 1.3 m high
1	0.1 cm to 1.9 cm dbh

How to Tag

Use the procedure described in Tagging by Sectors.

Tagging Forked Trees in Sub-plots

Here are special rules for tagging forked trees with a dbh of between 2 cm and 3.9 cm:

1. Tag the stem as a single tree if the fork occurs above 1.3 m.
2. Tag each stem separately if:
   - the fork occurs below 1.3 m, and
   - two or more of the forked stems have a dbh of 2 cm or greater.
3. Tag the stem as a single tree if:
   - the fork occurs below 1.3 m, and
   - only one of the forks' stems is 2.0 cm or greater.

Give special attention to the method of counting forked trees with stems less than 2 cm dbh. Certain trees have numerous leaders, which are the topmost shoots of a main stem. To avoid counting them all, count only the tallest leader. This rule only applies if the main leader is less than 2 cm dbh.

Gathering Data About the Sample

For each tagged tree, gather and record the following information:

- the tree number;
- the species;
- the tagging sector number;
- the site sector number;

- the dbh (must be $\geq$10.0 cm for dead trees);
- the tree class;
- pathological indicators or dead tree attributes;
- the crown class (living trees only);
- suitability for height measurement, (Y)es, (N)o, (C)ould be, (F)lagged, (V)ery difficult to measure, (E)asy to measure;
- the live-crown length (living trees only);
- damage agent codes, if applicable.

The data must be captured digitally in the field with an Electronic Field Recorder (EFR) using Gyhost/Gyhand software (see "Gyhost/Gyhand: A Data Collecting, Editing and Reporting System" on the Ministry's Web Page). In case of emergency (i.e. EFR breaks down) the data may be collected on field sheets and then later entered into the Gyhost/Gyhand system. For information on how to fill out the field sheets, see "Completing the Field Sheets" in Appendix 16. See Appendix 19 for a copy of the "Growth Sample Record Sheet".

Measuring the Trees

For tagged trees in the sample **with a dbh of 2 cm or more**, measure the diameter just above the nail to the nearest millimetre. Make sure the diameter tape is perpendicular to the bole of the tree, and is pulled tight. See Appendix 9.

Abnormal trees

For abnormal trees less than 2 cm dbh within the sub-plot, special measurement rules apply. See Appendix 10.

Classifying Trees

Classify each tagged tree according to its pathological indicators.

To classify a tree properly, view it from all sides. The person measuring dbh should move far enough away from the tree to be able to classify the lower third of the stem. The recorder should move around the tree to classify the upper two thirds.

Record each pathological indicator as occurring on the lower, middle or upper third of the total height of the tree. Do this by entering the following Pathological (Decay) Indicator Position Codes:

Code	Position on Tree (tree is divided into thirds)
1	Lower third
2	Middle third
3	Upper third
4	Lower and middle third
5	Middle and upper third
6	Lower and upper third
7	All thirds

Tree Classes

Each tagged tree is classed in one of the following categories:

1. Tree Class 1: Residual;
2. Tree Class 2: Suspect;
3. Tree Class 3: Dead potential;
4. Tree Class 4: Dead useless;
5. Tree Class 5: Veteran.

Tree Class 1: Residual

Record tree class 1 if:

- the tree is alive and free of pathological indicators.

Tree Class 2: Suspect

Record tree class 2 if:

- the tree is alive;
- the tree is not a veteran, and
- the tree has one or more pathological indicators.

Tree Class 3: Dead potential

Record tree class 3 if:

- tree is dead;
- the tree contains at least an estimated 50% of sound wood by volume, and
- the tree is 10 cm dbh or greater and 3.0 m or greater in height or length.

Tree Class 4: Dead useless

Record tree class 4 if:

- the tree is dead, and
- the tree is not potentially useful. See Tree Class 3.

Tree Class 5: Veteran

In simple stands, record tree class 5 if:

- a tree is at least 40 years older than the mean age of the main stand, and
- the veteran component has an estimated crown closure of less than 6% for the sample.

In complex stands, a tree is considered a veteran only when:

- it is a remnant of a much older stand;
- it is at least 100 years older than the mean age of the main stand, and
- it has a much larger diameter than the other trees in the stand. This criterion is necessary because of the subjectivity involved in determining what constitutes the main stand owing to the wide range of ages possible in it.

Veterans are not recognized in stands 121 years or older, except in lodgepole pine stands, which may have a veteran component of Douglas fir or larch.

Record pathological indicators for veteran trees the same way as for other trees.

Pathological Indicators

The indicators of decay (pathological indicators) are:

Fork or Crook is the result of damage to the main leader.

Scar must be weathered and may be open or closed.

Frost Crack may resemble a scar but always follows the grain.

Dead Top is a dead leader on a living tree.

Broken Top (record height to break, to nearest metre) is a broken leader.

Conk is the fruiting body of decay fungi.

Mistletoe is a parasitic flowering plant.

Blind Conk is pronounced swelling or depression around knots.

Rotten branch obviously decayed large branches with a DIB of over 10 cm.

See Appendix 11 for definitions and illustrations of these pathological indicators.

The following abnormalities are not pathological indicators:

- butt rot;
- flute;
- dry side;
- black knot;
- candelabra branch;
- branch fan;
- spiral grain;
- sapsucker hole;
- sweep;
- exposed root;
- insect boring;
- burl and gall.

Dead Tree Attributes

The following attributes are collected on dead trees that are 10.0 cm and greater in dbh in place of pathological indicators. See Appendix 22.

- **species certainty**;
- **vertical position**: standing only for establishment;
- **presence of breakage**;
- **height to break if broken**, ocular estimate;
- **damage agent code and severity** see Appendix 14;
- **wildlife tree appearance**.

Assessing whether a tree is still alive may be difficult in certain situations. Ensure that all needles are dead if the tree is being called dead, and if uncertain, err on the side of caution by calling it alive.

Assessing Damage Agents and Severity

We collect insect, disease and injury data to quantify their effect on tree growth.

For each tree affected:

1. Identify, if possible, the two most damaging agents (see Appendix 14 for damage agents and severity codes).
2. Assess the damage severity.
3. Record the damage agent code to a level that you are confident.
   - The damage agent codes are hierarchical and enable coding from very general (type or category) to specific (species). The first letter indicates the type of the damage while the second and third indicate the specific agent;
   - If you are unable to identify the damage agent species, a short, incomplete label is still useful. **Example**: You may identify a defoliating insect and assess the percent defoliation for the tree as 30 percent. Record this as ID_30.

For the sample affected:

1. Identify the two most damaging agents in the sample.
2. Calculate the percent assessment of each agent for the sample. Determine the damage severity to the nearest one percent up to ten percent and the nearest five percent for severities greater than ten percent.
3. Record this assessment in the header. If known, also record the year in which the damage took place.

Assigning a Crown Class Code

Crown class refers to the position of the crown of a tree relative to all other trees within the general plot area, not the whole stand.

There are 6 crown classes:

1. Crown class 1: Dominant;

2. Crown class 2: Codominant;
3. Crown class 3: Intermediate;
4. Crown class 4: Suppressed;
5. Crown class 5: Veteran;
6. Crown class 6: Understory.

For more details on crown classes, see Appendix 12.

Assign a crown class code of 1 through 6 to each tagged tree classed as tree class 1, 2 or 5 (see "Classifying Trees" in this chapter).

Note: Crown class 6 should be used sparingly; do not confuse it with crown class 4. Use crown class 6 only in stands 60 years or older where the understory trees, usually shade tolerant, are clearly much younger than the main stand.

Estimating Live-crown Length

Live-crown length is the distance between the treetop, if the top is alive, or from the top of the live portion, if the treetop is dead and the base of the lowest contiguous live crown. The estimate is expressed as a percentage of the total height of the tree.

Estimate, to the nearest 10 percent, the live-crown length of all living tagged trees.

- When determining the base of the lowest contiguous live crown, do not consider forks or epicormic branches;
- The tops of defoliated trees may appear dead at the time of the assessment. Make sure it is or you may underestimate the live-crown length.

Recording Stumps

In plots established in selectively logged stands, measure and record, by sector, information about each stump of a commercial species with a diameter at breast height of 12.5 cm or greater.

1. Identify stumps of commercial species with diameters of 12.5 cm or greater. Ignore non-merchantable stumps cut at the time of selective logging.
2. Assign each stump a tree number. Tree numbers for stumps range from 900 to 979. Tagging the stump is not necessary.
3. For each stump, determine:
    - the species;
    - height;
    - diameter;
    - whether the stump is new or old - under 10 years since cutting, or over 10 years?;
    - the tree number of the closest tagged tree.

Determining the Stand Structure

Stand structure is the physical arrangement or pattern of organization of the stand. Stand structure is described and classified according to recognizable age and height differences.

The recognized stand structures are:

1. Single layer, simple stands (even age and height)
    - with veterans
    - without veterans
2. Single layer, complex stands (uneven age and height)
    - with veterans
    - without veterans
3. Multi layer stands
    - layer 1 is the top layer
    - layer 2 is the bottom layer

For single layer stands, layer 1 is assumed for trees in the main stand and tree class 5 identifies the veteran layer.

For multi layer stands, record 1 for the top layer trees and 2 for the bottom layer. The sample primary layer, according to regional priorities, must be identified.

For further details on stand structure, see Appendix 13.

Height Sample Trees

Local height-diameter curves are constructed from sample data before compiling samples.

To construct reliable curves, a substantial number of heights are needed for each species. The number depends on the stand composition, which ultimately is based on basal area. In the field, use the calculated basal area for stand composition.

Top Height

Select the top height tree from a 0.01 ha circular plot at plot centre. Record "C" (centre sector) for the tree. Top height (1998) is the height of the largest diameter tree, regardless of species, in a 0.01 ha plot, providing the tree is suitable. A suitable tree must be healthy, not have a broken or damaged top, not have its height growth affected by a competitor nor be a residual left from previous logging. There is no substitution for an unsuitable tree.

If the PSP is one selected for SIBEC, select the largest diameter tree of each additional species in the 0.01 ha circular plot at plot centre, and record "C" (centre sector) for the tree.

For a single-layered stand, or for each layer in a multi-layered stand, select height sample trees as follows:

First Two Major Species

For each of the first two major species (20 percent or more by composition), select trees for the sample as follows:

1. Select the required number of site trees, to a maximum of ten. These trees are selected on the basis of the largest diameter tree per 0.01 ha plot or sector. Suitable trees have the following characteristics:

- largest diameter trees;
- living;
- free of major defects;
- crown class of 1 or 2. The exception is in the case of the second layer in a two-layer stand where crown class 3 and 4 are acceptable;
- cannot be substituted.

Example: On a 0.1 hectare sample, the ten largest dbh trees from each of the two leading major species are selected for site tree measurements. Similarly, four trees would be selected in a 0.04 hectare sample.

2. Select an additional 15 trees distributed evenly across the remaining dbh range, down to 2 cm dbh.

For Third and Fourth Majors, Minor and Scattered Species

For the third and fourth major species (20 per cent or greater by composition), each minor species (10 to 19 percent by composition) and for scattered species (less than 10 percent by composition), select 15 trees, if present and suitable. Distribute them across the dbh range, down to 2 cm dbh. Place emphasis on larger diameter classes.

For Veterans

For the veteran layer:

1. Select one tree for each species present.
2. Estimate the height of all others.
3. Record the estimated height in the small tree or Vet height section.

Selecting Sample Trees

When possible, select residual trees (tree class 1). See "Classifying Trees" in this chapter. Otherwise, select trees that do not have a major fork, which affects the true height, or a major scar at breast height, which affects the true diameter.

Do not select trees with:

- diameters that were estimated;
- sweeps or leans greater than 10 degrees.

In some areas, it may be impossible to meet sample height requirements if only suitable trees as described above are taken. In this situation, take the best of the "poor" trees to meet the requirements. However, do not select a tree if its height is less than 95% of what it would be without its defect - lean, fork, broken top, etc.

Measuring Suppressed Trees with Flattened Tops

To ensure accurate measurements of suppressed trees:

1. Sight on the highest point of the top.
2. For hemlock trees, sight on the highest point of the droop.

3. For cedar trees, make sure you take the top reading on the tiny leader and not on a lateral branch, which may be higher.

Measurement Consistency

To make sure the height measurement is taken consistently from the same location, paint a blue dot at dbh to indicate the direction from which you made the height measurement.

Age Sample Trees

In **single layer, simple stands**, pure and mixed, the age of the stand is determined by averaging the ages of the site trees of the leading major species on the plot. However, ages of the site trees of the second major species must also be taken.

The sample mean age is derived from the site trees of the leading species only, even if some of their cores are rotted. The rotted portion must be estimated to derive a total age for the tree. See "Counting Rings on Rotted Cores" in this chapter.

Bore trees that appear to be **veterans** to confirm they are in fact veterans. Bore the smallest diameter veteran per species only; the others can then be assumed to be veterans too. Use these ages for the veteran layer.

In **single layer, complex stands** determine the average age of the stand from the ages of the site trees of the leading major species. However, to show the variation of the stand's age, take two additional ages of the leading major species from the younger portion of the stand. Treat the second major species the same as the leading.

In **multi layer stands**, select sample trees, as outlined above, for each layer. The site tree method for determining site index is more suitable for even-aged stands. However, to simplify matters, select sample trees for both layers using the site tree requirements as above.

Taking the Age of a Tree

1. Bore the selected trees 1.3 m above the base of the tree on the uphill side.
2. Remove the core. Make sure two cores per species include the pith.
3. If the core includes the pith, record "Y" in the pith field.
4. Rebore the tree if you missed the pith by more than an estimated:
    - 2 years on a tree younger than 100 years, or
    - 2 percent on a tree older than 100 years.
5. While in the field, count the rings on the core and record the count. (Note that the first ring from the pith as 1 year, not pith).
6. Measure and record the radial increment for the last 5, 10 and 20 years.
7. Measure and record the evidence of suppression, if any. See Appendix 23.
8. Place the core in a plastic straw with the following information:
    - region number, R#;
    - compartment number, Co#;
    - sample number, G#;
    - tree number;

- species;
- counted age.

Counting Rings on Rotted Cores

If the sample tree has rotted:

1. Count the rings on the sound portion of the core.
2. Estimate the number of years in the rotten portion.
3. Add the number of years in the sound portion to the estimated number of years in the rotten portion.
4. Record the total breast-height age with an (R)otted for pith.

Boring Small Trees

If it is not possible to bore a small (less than 4 cm dbh) tree without damaging it:

1. Select a tree of a similar diameter and height outside the plot and bore it.
2. Assign the age to the plot tree.
3. Record (E)stimated for pith.

Estimating Other Plot Attributes

Estimating Crown Closure

Crown closure is the percentage of ground area covered by the vertically projected crowns of trees.

For each plot, estimate and record the crown closure by layer to the nearest 10 percent.

For the veteran component of the plot, record crown closure to the nearest percent. If the crown closure of the veteran component for the sample is 6% or more, it must be classified as a separate layer.

Determining Elevation

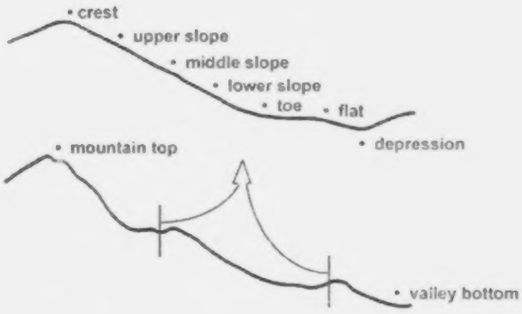
Determine and record the elevation of each plot.

Determining Aspect and Slope

Determine the aspect and slope for each plot.

Determining Slope Position

Slope position is the relative position of the plot within a water catchment area. Determine the slope position and record the appropriate code:

Code	Category	Slope position
C	Crest	
U	Upper	
M	Mid	
L	Lower	
T	Toe	
F	Flat (level)	
D	Depression	

Stem Mapping

Ten percent of samples established in natural stands are stem mapped. The Resources Inventory Branch decides which sample and stratum (type group, site, age class) to stem map. The stem maps are then used in distance-dependent growth modeling studies.

To create a stem map, you begin from the plot centre stake and measure the bearing and distance to each tagged tree. See Appendix 4 for a list of equipment needed for stem mapping.

To stem map the plot, follow this procedure:

1. If no large tree nearby interferes with sight lines, set up your compass directly over the plot centre stake:
   - level the instrument;
   - record that the compass was not offset.
2. If a large tree nearby interferes with sight lines, set up the compass in an opening close to the plot centre:
   - level the instrument;
   - measure and record the bearing and distance from the compass to the plot centre;
   - record that the compass was offset.
3. Adjust the compass for magnetic declination and raise the sighting vanes. In Western Canada, the magnetic declination is east of true north. Obtain the correct magnetic declination from an isogonic table. See Appendix 7.
4. Sight on to the first tree on the plot. Some tips for sighting are listed below:
   - to avoid sighting the wrong tree, wrap the dbh stick with flagging tape to make it more visible, then place the stick in front and center of the tree;
   - to avoid false compass readings as you sight the tree, keep sources of magnetic interference away from the compass, including steel tapes, axes, knives, steel datum holders, eye glasses with steel frames, and most metal objects;

- to simplify recording and possibly minimize errors, use a staff compass with Azimuth bearings when possible.

5. Measure the slope distance between the plot centre and the centre of the tree.
6. Measure the slope with the Suunto clinometer using the percent scale.
7. Read the compass bearing on the scale at the north end of the compass needle.
8. Record all measurements for each tagged tree in the plot.

Collecting Ecological Data

All samples established in natural stands are ecologically assessed. Collect and record ecological data to the Biogeoclimatic Ecosystem Classification (BEC) site series level. See Appendix 25. If it is not possible to collect the ground data at the time of measurement, at minimum, obtain the BEC Zone, Sub-Zone, and Variant.

Quality Assurance

Sampling crews should emphasize accuracy over production. For the standards of measurement see Appendix 1.

Checking Sampling Crews

To ensure crews follow and understand recommended procedures, carry out regular inspections.

1. Inspect at least 10 percent of all samples established. If the sample has been poorly done, the original crew may be required to redo it.
2. Make spot checks as work progresses to be sure tie points are properly marked and that tie lines are run on the designated bearings and horizontal distance.
3. To observe sampling crew performance, occasionally visit each crew on the sample.

Checking the Samples in the Office

All samples must be inspected in the office before sending them to the Vegetation Resources Inventory Section of the Terrestrial Information Branch. Check the following:

1. The sample identification is correct and valid.
2. The sample header is as complete as possible.
3. The minimum tree requirements were met for both plot and sub-plot.
4. The number and distribution of tree heights were met.
5. The required number of ages and piths were met.
6. The access notes are complete and include the tie point sketch.

Inspecting the Samples

Once the samples have been checked in the office, randomly select one of the plots and conduct the following:

1. A pre-field inspection.
2. A field inspection.
3. A post-field inspection.

Pre-field Inspection

1. Randomly select one of the samples from the ones checked in the office.
2. Enter the following information in the section at the top of the plot inspection report:
   - sample identification -- region, compartment, sample, sample type, plot;
   - the plot and sub-plot sizes;
   - the plot and sub-plot radii;
   - the inspection date;
   - the original tally crew;
   - the measurement date.
3. Randomly select seven live trees and two dead trees for tree detail checking.
4. Transcribe the measurements of the seven live trees and two dead trees to the top section of the plot inspection report. See Appendix 15.
5. Randomly select five trees from the sample tree section, for height checking.
6. Transcribe the height measurements of the five trees to the sample tree section of the plot inspection report.
7. Select two age cores and check the age count as well as the suppression readings.
8. Transcribe the crown closure, aspect, slope and slope position of the plot to the appropriate section of the plot inspection report.
9. Randomly select one tree count diameter class for a species. Later, use this diameter class in the field to check that the dot tally is correct for the species and class.

Note: Steps 2 to 9 are automatically done on the Gyhost/Gyhand Data Capture and Reporting System. Select the quality assurance report for printing.

Field Inspection

1. Use the access notes to get to the sample and verify their accuracy and completeness.
2. Check that the tie point is correctly marked. See "Choosing a Tie Point" in this chapter.
3. Make sure the tie line bearing and distance run within the allowable standards.
4. Make sure the plot centre markers are correctly inscribed, and that the plot centre stake is protected with a cairn.
5. Check the plot and sub-plot radius at a minimum of three different locations. Check for trees that were missed or that should have been excluded from the plot or sub-plot.

6. Within the plot or sub-plot, make sure trees larger than the tagging limits were not missed. Also check for trees that were tallied when they should not have. Flag with a circled asterisk any missed or erroneously tallied tree.
7. Make sure all sub-plot trees of the selected tree count class were counted in the dot tally.
8. Carefully measure all the trees selected for field inspection:
   - **Tree identification** - Make sure the genus or species of each tree is correct. If not, place a circled asterisk beside the tree.
   - **Tree tag height** - Check the tag height of the seven selected trees to verify that breast height is 1.3 m above the base of the tree on the uphill side. At the same time, make sure the nails were securely driven into the trees and the nail with the tag was driven in at a slight angle so that the tag hangs away from the tree.
   - **Diameter and pathological remarks** (decay indicators) - Measure the dbh of the seven live and two dead selected trees and classify them.
   - **Sample tree heights** - Measure the five selected trees for height.
   - **Stem mapping** - If the sample was stem mapped, check the seven selected trees for bearing, distance and percent slope.
9. Assess the crown closure for the plot.
10. Compare your measurements with the crew's measurements. Give the crew the benefit of the doubt.
11. Check that the results conform to the standards of measurements. See Appendix 1.
12. If the difference between two measurements is greater than the allowable error, place an asterisk in the margin.
13. If the error is greater than two times the allowable error, circle the asterisk.
14. Complete the inspection items section of the inspection report.
15. Rate the quality of the work on the plot using the weighted system in Appendix 2.
16. Record your rating of the sample and any other comments in the remarks section of the plot inspection report.

Post-field Inspection

1. Discuss the results of your inspection with the original field crew.
2. Make recommendations to the original field crew, if necessary, on how to improve their work.
3. Correct all the original data that was flagged with an asterisk or a circled asterisk in your inspection report.

Mapping Samples

Once you establish the samples:

1. Plot them on forest cover maps.
2. Send copies of the maps to the Terrestrial Information Branch.

Submitting the Samples

Once the samples are checked in the office and corrected:

1. Send a list of all the samples, any original field sheets, the electronic download from the GyHost as well as a hard copy of reports 1, 2, 3, 5 and 7 to the Vegetation Resources Inventory Section of the Terrestrial Information Branch.
2. Keep a copy of all the above for security and reference.

2. Remeasurement of Permanent Sample Plots in Natural Stands

Introduction

Samples in natural stands are remeasured every ten years. This interval should be maintained whenever possible. A list of samples with their establishment and remeasurement dates and map locations is regularly circulated to the regions so that remeasurement can be planned in advance.

The standards of measurement for permanent samples are listed in Appendix 1.

If not already done, ecologically classify, according to Research Branch specifications, all samples due for remeasurement.

Since permanent samples are cost intensive, protecting them is of the utmost importance. To ensure their protection, the protection buffers illustrated in Appendix 18 are recommended.

Preparing for Field Work

Before field work starts, prepare and collect:

Copies of the original field sheets

Maps to show you how to get to the sample – example, 1:250 000 contour maps – and photocopies of parts of forest cover maps, which have an approximate scale of 1:20 000 and show the plot's location in detail.

Photos showing original tie points, either those used when the sample was established, or, preferably, the latest photos on which tie points and sample locations were replotted.

Equipment. See Appendix 4 for the equipment needed.

Field Training

All personnel involved in remeasurement work must attend a field procedures course.

Relocating the Plot

Checking Location and Access

The notes on the location of the plot and access to the plot usually begin with a description of an easily identifiable point.

1. Follow the access notes to the tie point.

2. Correct the notes where necessary.

The reference or tie point generally is a prominent topographic feature distinguishable on the photos and on the ground. **Examples:** a road junction, road bend, creek junction or bridge.

The blazed and/or painted tie tree should be located nearby, as described in the access notes. Aluminum sample markers were nailed to the tie tree, and strands of plastic flagging tape should still be noticeable on or near the tree.

The aluminum marker contains pertinent sample information such as:

- region number;
- compartment number;
- sample type (G);
- sample number and plot number (usually 1, but 3-plot samples exist);
- bearing and distance to the plot centre;
- date the sample was established.

For more information on sample markers, see Appendix 5.

New Tie Point Needed

If a new tie point is needed:

1. Select a new tie point recognizable on the photos and the ground.
2. From the map, measure and record the new bearing and distance to the plot centre.
3. Paint both sides of the tie tree in the direction of the tie line.
4. Nail an aluminum sample marker above the paint.
5. Inscribe the pertinent information on the middle and bottom sections of the 2 markers. **Note:** "Date" on the marker always refers to the date the sample was originally established. See Appendix 5.
6. Flag the tie tree with two strands of flagging tape, one above and one below the markers.
7. To aid future measurement crews, prepare a sketch showing the tie point, the sample location, and other significant topographic features. Attach the sketch to the access notes.

If you establish a new tie point, you must run a new tie line.

Checking the Tie Line

The tie line is run from the tie point with a hand compass, a clinometer and a measuring tape. When you rerun the original tie line, it is sufficient to paint the blazes, and to renew the tape markings.

Checking the Centre Tree

Each established plot has a centre tree marked with aluminum markers and strands of flagging tape. The markers and tape are usually secured about two metres above ground to avoid interfering with dbh measurements. If the centre tree is missing, either because of natural causes or because somebody cut it down:

1. Select another centre tree near the plot centre.
2. Mark it with the two aluminum markers and flagging tape.

Checking the Plot Centre Tree Markers

Missing or Illegible Plot Markers

Discovering missing or illegible plot centre tree markers is not unusual. Here's how to proceed:

1. Replace the old markers. Centre tree markers are the same as those used for tie point trees. See Appendix 5.
2. Complete the top and bottom sections of the markers. Include the following information:
    - sample type (G);
    - sample number;
    - plot number;
    - region number;
    - compartment number;
    - date the plot was established.

When the Plot Centre Is Also a Tie Point

Very often the plot centre also serves as a tie point for the next plot on the tie line. When it is, the middle section of the marker should also be filled out.

Checking the Plot Centre Stake

The plot centre is marked by a tubular aluminum stake either driven into the ground or supported by a cairn on rocky ground. You can usually identify the stake by the flagging tape on it. If the plot centre stake location has never been stem mapped, select three trees around the plot centre and record the bearing, slope, and distance from the plot centre stake to the centre of each tree. Place a nail at the centre of each tree for consistency in measuring distance to the centre stake.

Replace the plot centre stake if the stake is:

- missing;
- pulled out but lying on the ground;
- bent but still in the original location.

Replacing a bent stake is not difficult because it's still stuck in the ground. For a stake found lying on the ground, you may locate its original position by simply looking around for signs of the plot centre location.

In Case the Stake is Missing

Unless the centre stake location was stem mapped, relocating a missing plot centre stake is a difficult, time-consuming, but necessary task.

If the centre stake location was not stem mapped:

1. Tally the original trees on the plot before relocating the centre stake. Some tags may be down or missing, so replace them before relocating the centre stake.
2. Determine the approximate centre by observing the layout of the sectors.
3. Find trees close to the plot perimeter and measure the plot radius from those trees until you determine the approximate plot centre. Using the 'approximate plot centre' and the plot radius as a starting point, check that all tagged trees are in the plot. If not, adjust the plot centre until they are.
4. If not already done, build a cairn around the newly relocated plot centre stake.
5. Measure the bearing, slope percent, and slope distance from the plot centre to 3 trees nearby. Place a nail at the centre of each tree for consistency in measuring distance to the centre stake.
6. In sample remarks, record that the centre stake was missing.

Remeasuring the Plot and Sub-plot

Accurate work is required when you compare new measurements with previous ones. Always position the dbh tape just above the nail and perpendicular to the bole of the tree. Check measurements that appear to be out of the expected range, that is, measurements showing a very large increase compared with those showing little or no increase.

Correct any errors and note them in the remarks. **Example**: "dbh checked."

Converting Breast Height in Industrial Permanent Samples

See Appendix 21 for procedures to convert, if needed, industrial permanent sample plots (PSPs) from imperial (1.37 m) to metric (1.3 m) breast height.

Sectors in the Plot

Plots were generally divided into eight tagging sectors with number one starting clockwise from the direction of the original tie line or, in later years, from the north. In order to aid in the choosing of top height and site trees, the plot must also be divided into 0.01 ha site sectors using the same procedure previously used - that is starting clockwise from the direction of the original tie line or from north. See Appendix 24.

Tagging Trees

Determine the breast height of trees with missing tags, as well as of ingrowth trees. In 1991, breast height determination changed from using the point of germination to using the base of the tree on the uphill side. Therefore:

- for samples established **before 1991**, continue using the point of germination

- for samples established **after 1990**, use the base of the tree on the uphill side

Up to 1979, all living trees had the tree tag nailed and dbh taken at 1.37 m above germination point. During the remeasurements from 1980 to 1989 inclusive, the dbh height and dbh were changed to 1.3 m above germination in one of two ways (see Appendix 21). If **Method 1** was used, you will have to remove the nail at 1.3 m and replace it with the nail and tag that is at 1.37 m.

Note: If a plot is being remeasured that has not had the dbh changed from 1.37 m to 1.3 m, do it now following Method 2 in Appendix 21.

Missing Tags

For all previously measured living trees with missing tags:

1. Determine breast height at 1.3 m above germination, or 1.3 m above the base of the tree on the uphill side for samples established after 1990.
2. Nail a tag which has the same tag number as the missing one.

Finding Missing Tags

During the establishment, tagging began near the centre in sector 1 and continued in a zigzagging pattern toward the circumference with the tags facing the plot centre. Once all taggable trees in sector 1 were tagged, the procedure was repeated in sector 2, only this time tagging began at the circumference with the tags facing away from the plot centre. The procedures for tagging sectors 1 and 2 were repeated alternately for all remaining sectors of the plot.

Measuring DBH

For all **numbered living trees**, measure above the nail, to the nearest millimetre, the diameter at 1.3 m.

To more accurately measure the diameter of trees that are or will soon be joined together at dbh, use the "1/2 wrap" method. To do this, measure or estimate, as accurately as you can, the diameter of each affected tree. Then, from the nail with the tag, measure half of the diameter around the bole of the tree and place a second nail. Note in the remarks that these are "1/2 wrap" measurements. In the future, the distance between the two nails will be measured and multiplied by two to arrive at the diameter of the tree.

After remeasuring the diameter:

- Pull out the nail holding the number enough to allow for tree growth until the next remeasurement.

For all **previously numbered living trees now dead**:

1. Measure the diameter above the nail at 1.3 m.
2. If you can't find the dead tree, assign it the same diameter as in the previous measurement. If the tree was cut down, record it as Tree Class 6 and assign the same diameter as in the previous measurement.

For all **previously dead numbered trees that are ≥10.0 cm dbh and ≥1.3 m in height:**

1. If standing, or down, collect the appropriate '*Dead tree Attributes*'. See Appendix 22.
2. If you cannot find the tree, record it as (**F**)allen.

For all **previously dead, standing, unnumbered trees that are ≥10.0 cm dbh and ≥1.3 m in height:**

1. Tag the tree with a unique number.
2. Collect the '*Dead tree Attributes*'. See Appendix 22. Assessing whether a tree is still alive may be difficult in certain situations. Ensure that all needles/leaves are dead if the tree is being called dead, and if uncertain, err on the side of caution by calling it alive.

Classifying Trees

Classify each tagged tree according to its pathological indicators.

To classify a tree properly, view it from all sides. The person measuring dbh should move far enough away from the tree to be able to classify the lower third of the stem. The recorder should move around the tree to classify the upper two thirds.

Record each pathological indicator as occurring on the lower, middle or upper third of the total height of the tree. Do this by entering the following Pathological (Decay) Indicator Position Codes:

Code	Position on Tree (tree is divided into thirds)
1	Lower third
2	Middle third
3	Upper third
4	Lower and middle third
5	Middle and upper third
6	Lower and upper third
7	All thirds

Tree Classes

Each tagged tree is classed in one of the following categories:

1. Tree Class 1: Residual;
2. Tree Class 2: Suspect;
3. Tree Class 3: Dead potential;
4. Tree Class 4: Dead useless;
5. Tree Class 5: Veteran;
6. Tree Class 6: Dead, cut down.

Tree Class 1: Residual

Record Tree Class 1 if:

- the tree is alive, not a veteran and free of any decay indicators.

Tree Class 2: Suspect

Record Tree Class 2 if:

- the tree is alive;
- the tree is not a veteran, and;
- the tree has one or more decay indicators.

Tree Class 3: Dead Potential

Record Tree Class 3 if:

- the tree is dead, either standing or down;
- the tree contains at least an estimated 50% of sound wood by volume, and;
- the tree is greater than or equal to 10 cm dbh and greater than or equal to 3 m in height or length.

If you can determine the tree died as a result of an insect or a disease, record the primary insect or disease responsible for the death. See Appendix 14 for damage agents and severity codes.

Tree Class 4: Dead Useless

Record Tree Class 4 if:

- the tree is dead, either standing or down;
- the tree is not potentially useful. See Tree Class 3.

If you can determine the tree died as a result of an insect or a disease, record the primary insect or disease responsible for the death. See Appendix 14 for damage agents and severity codes.

Tree Class 5: Veteran

For simple stands, record Tree Class 5 if:

- a tree is at least 40 years older than the mean age of the main stand;
- the veteran component has an estimated crown closure of less than 6% for the sample.

In complex stands, a tree is considered a veteran only when it:

- is a remnant of a much older stand;
- is at least 100 years older than the oldest sample trees of the main stand;
- has a much larger diameter than trees in the main stand. This criterion is necessary because of the subjectivity in determining what constitutes the main stand owing to the wide range of ages possible in it.

Veterans are not recognized in stands 121 years or older, except in lodgepole pine stands, which may have a veteran component of Douglas fir or larch.

Record pathological indicators for veteran trees the same way as for other trees.

Tree Class 6: Dead, Cut Down

Record Tree Class 6 if the tree is dead as a result of being cut down.

Pathological Indicators

The indicators of decay (pathological indicators) are:

Fork or Crook the result of damage to the main leader.

Scar must be weathered and may be open or closed.

Frost Crack may resemble a scar but always follows the grain.

Dead Top is a dead leader on a living tree.

Broken Top (record height to break, to the nearest metre) is a broken leader.

Conk the fruiting body of decay fungi.

Mistletoe is a parasitic flowering plant.

Blind Conk pronounced swelling of depression around knots.

Rotten branch obviously decayed large branches with a DIB of over 10 cm.

See Appendix 11 for definitions and illustrations of these pathological indicators.

The following abnormalities are not pathological indicators.

- butt rot
- flute
- candelabra branch
- branch fan
- black knot
- burl and gall
- sapsucker hole
- insect boring
- sweep
- exposed root
- spiral grain
- dry side

Assessing Damage Agents and Severity

We collect insect, disease and injury data to quantify their effect on tree growth.

For each tree affected:

1. Identify, if possible, the two most damaging agents (see Appendix 14 for damage agents and codes).
2. Assess the damage severity.
3. Record the damage agent code to a level that you are confident.
    - The damage agent codes are hierarchical and enable coding from very general (type or category) to specific (species). The first letter indicates the type of the damage while the second and third indicate the specific agent.

- If you are unable to identify the damage agent species, a short, incomplete label is still useful. Example: You may identify a defoliating insect and assess the percent defoliation for the tree as 30 percent. Record this as ID_30.

For the sample affected:

1. Identify the two most damaging agents in the sample.
2. Calculate the percent assessment of each agent for the sample. Determine the damage severity to the nearest one percent up to ten percent and to the nearest five percent for severities greater than ten percent.
3. Record this assessment in the header. If known, also record the year in which the damage took place.

Assigning a Crown Class Code

Crown class refers to the position of the crown of a tree relative to all other trees within the general plot area, not the whole stand.

There are six crown classes:

1. Crown Class 1: Dominant;
2. Crown Class 2: Codominant;
3. Crown Class 3: Intermediate;
4. Crown Class 4: Suppressed;
5. Crown Class 5: Veteran;
6. Crown Class 6: Understory.

For more details on crown classes, see Appendix 12.

Assign a crown class code of 1 through 4 and 6 to each tagged tree classed as Tree Class 1 or 2. For tree class 5, assign crown class 5 (see "Classifying Trees" in this chapter).

Note: Crown Class 6 should be used sparingly; do not confuse it with Crown Class 4. Use Crown Class 6 only in stands 60 years or older where the understory trees, usually shade tolerant, are clearly much younger than the main stand.

Estimating Live-crown Length

Live-crown length is the distance between the treetop, if the top is alive, or from the top of the live portion, if the treetop is dead, and the base of the lowest contiguous live crown. The estimate is expressed as a percentage of the total height of the tree.

Estimate, to the nearest 10 percent, the live-crown length of all living tagged trees.

- When determining the base of the lowest contiguous live crown, do not consider forks or epicormic branches;
- The tops of defoliated trees may appear dead at the time of the assessment. Make sure it is or you may underestimate the live-crown length.

Tagging Ingrowth Trees

The term ingrowth trees refers to commercial and non-commercial trees that were below the tagging limit during the last measurement but now meet or exceed that limit.

When all previously numbered trees have been remeasured, tag all commercial and non-commercial living trees now 4 cm and greater at dbh by consecutive number for the plot.

Dealing with Forked Trees

Special rules govern the tagging of forked trees:

- If the fork occurs **above 1.3 m**: Tag the stem as a single tree, provided it has a dbh of at least 4 cm;
- If the fork occurs **below 1.3 m**, and two or more stems of the fork are 4 cm or greater in dbh: Tag each stem separately using consecutive numbers. Record, in the remarks, that these stems are forked together.
- If the fork occurs **below 1.3 m, and only one of the stems is 4 cm or greater**: Tag it as a single tree.

Tagging Procedure for Ingrowth Trees

1. If a large number of ingrowth trees are present, use consecutive, pre-numbered blue plastic tags. If few trees are present, use aluminum tags and inscribe the consecutive tree numbers for the plot.
2. Nail the tag to the tree 1.3 m above the germination point—or above the base of the tree on the uphill side, for samples established after 1990.
3. Do not use previously used numbers within the plot.

For plots in dense stands, string the plot circumference beforehand.

Recording Data About the Sample:

For each tagged tree (4.0 cm + if alive or 10 cm + if dead) ensure that the following information is recorded:

- the tree number;
- the species;
- the tagging sector number;
- the site sector number;
- the dbh;
- the tree class;
- any pathological indicators or dead tree attributes;
- the crown class (living trees only);
- suitability for height measurement, (Y)es, (N)o, (C)ould be, (F)lagged, (V)ery difficult to measure, (E)asy to measure;
- the live-crown length;
- damage agent codes, if applicable;
- the tree number of the closest, previously numbered living tree (if ingrowth).

The data must be captured digitally in the field with an Electronic Field Recorder (EFR) using Gyhost/Gyhand software (see "Gyhost/Gyhand: A Data Collecting, Editing and Reporting System" on the Ministry's Web page. In case of emergency (i.e. EFR breaks down) the data may be collected on field sheets and then later entered into the Gyhost/Gyhand system. For information on how to fill out the field sheets, see "Completing the Field Sheets" in Appendix 16. See Appendix 19 for a copy of the "Growth Sample Record Sheet".

Note: Previously classified trees that are now considered to be shrubs must be dropped (code "D" for drop) from the sample and tags removed.

Sub-plot and Tree Count

To have some representation from trees below the plot tagging limit, a sub-plot was established for each sample. The objective was to obtain a total of 20 living commercial trees that were less than the plot tagging limit but at least 0.3 m in height. For a list of sub-plot radii, see Appendix 6.

Within the sub-plot, all living commercial trees **2 cm dbh and greater but less than the plot tagging limit** were tagged using method 1 or method 2, previously mentioned in "Tagging Trees" in this chapter.

Trees of commercial species **less than 2 cm dbh but 0.3 m in height** had their tags wired onto either a branch or the main stem. These tags and wires should be removed if possible to prevent girdling of the stems.

Measuring Sub-plot Trees

For trees 2 cm dbh and greater previously tagged within the sub-plot, use the same method as in the main plot. See "Tagging Trees" in this chapter.

Attach a number tag to the tree with a nail at breast height (1.3 m) if the tree:

- was less than 2.0 cm dbh during the last measurement;
- has now a dbh of 2 cm or greater, and;
- is a commercial species.

Include the tree in the dot count if the tree:

- is less than 2 cm dbh, and;
- is a commercial species.

Special rules govern the tagging of forked trees **at least 2 cm dbh but less than 4 cm dbh** within the sub-plots:

- If the fork occurs above 1.3 m, tag the stem as a single tree;
- If the fork occurs below 1.3 m, tag each fork as a tree, provided each is 2 cm dbh and greater.

Gathering & Recording Information About Sub-plot Trees

Trees 2 cm dbh and greater:

For each tree 2 cm dbh and greater in the sub-plot, record the following:

- the tree number;
- the species;
- the tagging sector number;
- the site sector number;
- the dbh;
- the tree class;
- any pathological indicators;
- the crown class;
- the live-crown length;
- damage agent codes, if applicable;
- suitability for height measurement, (Y)es, (N)o, (C)ould be, (F)lagged, (V)ery difficult to measure, (E)asy to measure;
- the number of the closest previously tagged plot living tree.

Trees Less than 2 cm dbh:

Count trees less than 2 cm dbh in a dot tally and record them:

- as dbh class 0 or 1. See Table 1 below
- by species. See Appendix 3

Table 1. Metric dbh Classes and Limits

dbh class	Limits
0	0.3 m to 1.3 m high
1	0.1 cm to 1.9 cm dbh

Forked Trees Less than 2 cm dbh:

Give special attention to the method of counting forked trees less than 2 cm dbh. **Example**: To avoid counting numerous leaders of trees that have been severely browsed, count only the tallest leader. See Appendix 10 for a further explanation.

Unusual trees:

Now and then, you will find unusual live trees within the sub-plot. Special rules apply when measuring the height of abnormal trees less than 2.0 cm dbh. See Appendix 10.

Determining the Stand Structure

Stand structure is the physical arrangement or pattern of organisation of the stand. Stand structure is described and classified according to recognizable age and height differences.

The recognized stand structures are:

1. Single layer, simple stands (even age and height)
    - with veterans
    - without veterans
2. Single layer, complex stands (uneven age and height)
    - with veterans
    - without veterans
3. Multi layer stands
    - layer 1 is the top layer
    - layer 2 is the bottom layer

For single layer stands, layer 1 is assumed for trees in the main stand and tree class 5 identifies the veteran layer.

For multi layer stands, record 1 for the top layer trees and 2 for the bottom layer. The sample primary layer, according to regional priorities, must be identified.

For further details on stand structure, see Appendix 13.

Height Sample Trees

Local height-diameter curves are constructed from sample data before compiling samples.

To construct reliable curves, a substantial number of heights is needed for each species. The number depends on the stand composition, which ultimately is based on basal area. In the field, use the calculated basal area for stand composition.

Top Height

Select the top height tree from a 0.01 ha circular plot at the plot centre. For three-plot samples, select the top height tree only on the middle plot of the three-plot cluster. Record "C" (centre sector) for the tree. Top height (1998) is the height of the largest diameter tree, regardless of species, in a 0.01 ha plot, providing the tree is suitable. A suitable tree must be healthy, not have a broken or damaged top, not have its height growth affected by a competitor nor be a residual left from previous logging. There is no substitution for an unsuitable tree.

If the PSP is one selected for SIBEC, select the largest diameter tree of each additional species in the 0.01 ha circular plot at plot centre, and record "C" (centre sector) for the tree.

For a single-layered stand, or for each layer in a multi-layered stand, select height sample trees as follows:

First Two Major Species

For each of the first two major species (20 percent or more by composition), select trees for the sample as follows:

1. Select the required number of site trees on the basis of the largest diameter living tree per 0.01 ha plot or sector, to a maximum of ten. In the case of a sample larger than 0.1 ha,

randomly select ten site sectors and take the site trees from them - do not substitute. In future remeasurements, the same sector numbers will be used to choose site trees.

Suitable site trees have the following characteristics:

- free of major defects;
- crown class of 1 or 2. The exception is in the case of the second layer in a two-layer stand where crown class 3 and 4 are acceptable;
- cannot be substituted.

Example: On a 0.1 hectare sample, the ten largest dbh trees from each of the two leading major species are selected for site tree measurements. Similarly, four trees would be selected in a 0.04 hectare sample.

2. Select an additional 15 trees distributed evenly across the remaining dbh range, down to 2 cm dbh.

For Third and Fourth Majors, Minor and Scattered Species

For the third and fourth major species (20 per cent or greater by composition), each minor species (10 to 19 percent by composition) and for scattered species (less than 10 percent by composition), select 15 trees, if present and suitable. Distribute them across the dbh range, down to 2 cm dbh. Place emphasis on larger diameter classes.

For Veterans

For the veteran layer:

1. Select one tree for each species present;
2. Estimate the height of all others;
3. Record the estimated height in the small tree or Vet height section.

Remeasuring Heights Consistently

To ensure future height measurements are taken consistently from the same direction, paint a blue dot, if not already done, at dbh to indicate the direction from which the height measurement was taken.

Ensure that height sample trees previously taken are remeasured for height and from the same direction as indicated by the blue painted dot (unless no longer suitable) even if the resultant distribution over the dbh classes is not optimum. If possible, strive for the full range of diameters down to 2 cm dbh.

Selecting Sample Trees

When possible, select residual trees (Tree Class 1). See "Classifying Trees" in this chapter. Otherwise, select trees that do not have major suspect characteristics, such as a major fork, which affects the true height, or a major scar at breast height, which affects the true diameter.

Do not select trees with:

- diameters that were estimated;

- sweeps or leans greater than 5 degrees.

In some areas, it may be impossible to meet sample height requirements if only suitable trees as described above are taken. In this situation, take the best of the "poor" trees to meet the requirements. However, do not select a tree if its height is less than 95% of what it would be without its defect – lean, fork, broken top, etc.

Measuring Suppressed Trees with Flattened Tops

To ensure accurate measurements of suppressed trees:

1. Sight on the highest point of the top.
2. For hemlock trees, sight on the highest point of the droop.
3. For cedar trees, make sure you take the top reading on the tiny leader and not on a lateral branch, which may be higher.

Age Sample Trees

Note: If the present top height and site trees had their ages taken at 1.3 m during the last measurement, no further ages are required. If the top height tree or any site tree of the first and second leading major species, do not have an age at 1.3 m, it must be taken now and recorded in the "New Age" field.

In **single layer, simple stands,** pure and mixed, the age of the stand is determined by averaging the ages of the trees of the leading major species in the sample. However, ages of the site trees of the second major species must also be taken.

The sample mean age is derived from the site trees of the leading species only, even if some of their cores are rotten. The rotten portion must be estimated to derive a total age for the tree. See "Counting Rings on Rotted Cores" in this chapter.

Bore trees that appear to be veterans to confirm they are in fact veterans. Bore the smallest diameter veteran per species only; the others can be assumed to be veterans too. Use these ages for the veteran layer.

In **single layer, complex stands**, the average age of the stand is determined from the ages of the site trees of the leading major species. However, to show the variation of the stand's age, take two additional ages of the leading major species from the younger portion of the stand. Treat the second major species the same as the leading.

In **multi-layer stands**, select sample trees, as outlined above, for each layer.

Taking the Age of a Tree

1. Bore the selected trees at 1.3 m.
2. Remove the core. Make sure two cores per species include the pith.
3. If the core includes the pith, record "Y" in the pith field.
4. Rebore the tree if you missed the pith by more than an estimated:
   - years on a tree younger than 100 years, or
   - percent on a tree older than 100 years.

5. While in the field, count the rings on the core and record the count.
6. Measure and record the radial increment for the last 5, 10 and 20 years.
7. Measure and record the evidence of suppression, if any. See Appendix 23.
8. Place the cores in plastic straws with the following information:
   - the region number, R#
   - the compartment number, Co#
   - the sample number, G#
   - tree number
   - species
   - counted age

Counting Rings on Rotted Cores

If the sample tree has rotten portions:

1. Count the rings on the sound portion of the core.
2. Estimate the number of years in the rotten portion.
3. Add the number of years in the sound portion to the estimated number of years in the rotten portion.
4. Record the total breast-height age with an (**R**)otted for pith.

Estimating Other Plot Attributes

Estimating Crown Closure

Crown closure is the percentage of ground area covered by the vertically projected crowns of trees.

For each plot, estimate and record the crown closure by layer to the nearest 10 percent.

For the veteran component of the plot, record crown closure to the nearest percent. If the crown closure of the veteran component for the sample is six percent or more, it must be classified as a separate layer.

Determining Elevation

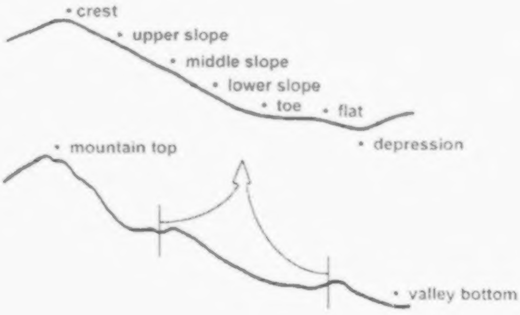
Determine and record the elevation of each plot if not already done.

Determining Aspect and Slope

Determine the aspect and slope for each plot if not already done.

Determining Slope Position

Slope position is the relative position of the plot within a water catchment area. Determine the slope position and record the appropriate code:

Code	Category	Slope Position
C	Crest	
U	Upper	
M	Mid	
L	Lower	
T	Toe	
F	Flat (level)	
D	Depression	

Stem Mapping

If the sample was previously stem mapped, you only have to stem map the tagged ingrowth trees in both the plot and the sub-plot.

Ten percent of the samples established in natural stands are stem mapped. The Resources Inventory Branch decides which sample and stratum (type group, site, age class) to stem map. The stem maps are used in distance-dependent growth modelling studies.

To create a stem map, you begin from the plot centre stake and measure the bearing and distance to each tagged tree. See Appendix 4 for a list of equipment needed for stem mapping.

To stem map the plot, follow this procedure:

1. If no large tree nearby interferes with sight lines, set up the compass directly over the aluminum plot centre stake, then:
   - level the instrument;
   - record that the compass was not offset.
2. If a large tree interferes with sight lines, set up the compass in an opening close to the plot centre, then:
   - level the instrument;
   - measure and record the bearing and distance from the compass to the plot centre;
   - record that the compass was offset.
3. Adjust the compass for magnetic declination and raise the sighting vanes. In western Canada, magnetic declination is east of true north. Obtain the correct magnetic declination from an isogonic chart. See Appendix 7.
4. Sight on to the first tree on the plot. Some tips for sighting are listed below:
   - to avoid sighting the wrong tree, wrap the dbh stick with flagging tape to make it more visible, then place the stick in front and center of the tree;

- to avoid false compass readings as you sight the tree, keep sources of magnetic interference away from the compass, including steel tapes, axes, knives, steel datum holders, eye glasses with steel frames, and most metal objects;
- to simplify recording and possible minimize errors, use a staff compass with Azimuth bearings when possible;

5. Measure the slope distance between the compass and the centre of the tree;
6. Measure the slope with the Suunto clinometer using the percent scale;
7. Read the compass bearing on the scale at the north end of the compass needle;
8. Record the measurements for each tagged tree in the plot.

Collecting Ecological Data

All samples established in natural stands are ecologically assessed. If not already done, collect and record ecological data to the Biogeoclimatic Ecosystem Classification (BEC) site series level. See Appendix 25. If it is not possible to collect the ground data at the time of measurement, at minimum, obtain the BEC Zone, Sub-Zone, and Variant.

Quality Assurance

Sampling crews should emphasize accuracy over production. For the standards of measurement see Appendix 1.

Checking Sampling Crews

To ensure crews follow and understand recommended procedures, carry out regular inspections.

1. Inspect at least 10 percent of all samples remeasured. If the sample has been poorly done, the original crew may be required to redo it.
2. Make spot checks as work progresses to be sure tie points and tie lines are properly marked.
3. To observe sampling crew performance, occasionally visit each crew on the sample.

Checking the Samples in the Office

All samples must be inspected in the office before sending them to the Vegetation Resources Inventory Section of the Terrestrial Information Branch. Ensure that:

1. The sample identification is correct and valid.
2. The sample header is as complete as possible.
3. The number and distribution of tree heights - both top height and others - were met.
4. The required number of ages and piths were met.
5. The access notes are complete and include the tie point sketch.

Inspecting the Sample

Once the samples have been checked in the office, randomly select one of the samples and conduct the following:

- a pre-field inspection;
- a field inspection;
- a post-field inspection.

Pre-field Inspection

1. Randomly select one plot from the ones checked in the office.
2. Enter the following information in the section at the top of the plot inspection report:
    - sample identification – region, compartment, sample, sample type, plot;
    - the plot and sub-plot sizes;
    - the plot and sub-plot radii
    - the inspection date;
    - the original tally crew;
    - the measurement date.
3. Randomly select 7 live trees and 2 dead from the tree detail section.
4. Transcribe the measurements of the 7 live trees and 2 dead to the top section of the plot inspection report. See Appendix 15.
5. Randomly select five trees for height from the sample tree section.
6. Transcribe the height measurements of the 5 trees to the sample tree section of the plot inspection report.
7. Select two age cores and check the age count as well as the suppression readings.
8. Transcribe the crown closure, aspect, slope and slope position of the plot to the appropriate section of the plot inspection report.
9. From the tree count summary section, randomly select one diameter class for a species. Later, you will use this diameter class in the field to check that the dot tally is correct for that class.

Note: Steps 2 to 9 are automatically done on the Gyhost/Gyhand Data Capture and Reporting System. Select the quality assurance report for printing.

Field Inspection

1. Use the access notes to get to the sample and verify their accuracy and completeness.
2. If a new tie tree was selected on remeasurement, check that it was marked as specified in "Checking Location and Access" in this chapter.
3. If a new tie line was run, verify that the bearing and distance were run within the allowable standards.
4. Check that the plot centre markers were inscribed correctly and the plot centre stake was properly protected with a cairn.

5. Check the plot and sub-plot radius at a minimum of three different locations. Look for trees that should have been included or excluded from the plot or sub-plot. Flag with a circled asterisk any tree missed or mistakenly tallied.
6. Check that the chosen diameter class was properly dot tallied.
7. Carefully measure all the trees you selected in the pre-field inspection:
    - **Tree identification** - Check that the genus or species of each tree inspected is correct. If not, place a circled asterisk beside the tree.
    - **Tree tag height** - Check the tag height of the selected ingrowth trees to verify that breast heights, if applicable, were located at 1.3 m above the germination point for plots established before 1991, or at 1.3 m above the base of the tree on the uphill side for plots established after 1990. At the same time, make sure the nails were securely driven into the trees and the nail with the tag was driven in at a slight angle so that the tag hangs away from the tree.
    - **Diameter and pathological remarks** (decay indicators) - Measure the 7 live and 2 dead selected trees and classify them.
    - **Sample tree heights** - Measure the 5 selected trees for height.
    - **Stem mapping** - If the sample was stem mapped, check the selected ingrowth trees for bearing, distance and percent slope.
8. Assess the crown closure for the plot.
9. Compare your measurements with the crew's measurements. Give the crew the benefit of the doubt.
10. Check that the results conform to the standards of measurements. See Appendix 1.
11. If the difference between two measurements is greater than the allowable error, place an asterisk in the margin.
12. If the error is greater than two times the allowable error, circle the asterisk.
13. Complete the inspection items section of the inspection report.
14. Rate the quality of the work on the plot using the weighted system in Appendix 2.
15. Record your rating of the plot and any other comments in the remarks section of the plot inspection report.

Post-field Inspection

1. Discuss the results of your inspection with the original field crew.
2. Make recommendations to the original field crew, if necessary, on how to improve their work.
3. Correct the original data changing all the data that was flagged with an asterisk or a circled asterisk in your inspection report.

Damage to the Sample and Returning the Samples

Damage to the Sample

Damage to samples can result from natural or artificial causes.

1. If the sample was damaged by natural causes such as slides, snow, fungi, insects, disease and fire, it should be remeasured if at least 25% of the plot trees are still living.
2. If the sample was damaged (disturbed) by artificial means, refer to "Guidelines For Deciding if Damaged Permanent Plots Should be Remeasured" in Appendix 20.

If a sample is to be destroyed:

1. Remeasure it one last time if at least three years have elapsed since the last measurement.
2. Classify it ecologically.
3. Make sure the plot centre can be relocated after logging so that the long-term productivity effects can be determined.

Returning the Samples

Once the samples are checked in the office and corrected:

1. Send a list of all the samples, any original field sheets, the electronic download from the GyHost as well as a hard copy of reports 1,2,3,5,6 and 7 to the Vegetation Resources Inventory Section of the Terrestrial Information Branch.
2. Keep a copy of all the above for security and reference.

3. Remeasuring Experimental Plots in Natural Stands

Introduction

From 1921 until 1949, the Research Branch established permanent plots to evaluate the growth and yield of different forest types. To protect this large investment from any type of disturbance, a reserve was placed around each plot. In 1957, the Research Branch transferred responsibility for 65 experimental plots, all of them still in a natural state, to the Resources Inventory Branch.

Since then, the Growth and Yield Section has continued to remeasure them at 10-year intervals. Some of the original 65 plots were abandoned owing to increased pressure on the area for other uses, or to the fact that sufficient data had been collected.

The standards of measurement for permanent samples are listed in Appendix 1.

If not already done, ecologically classify, according to Research Branch specifications, all experimental samples due for remeasurement.

Since permanent samples are cost intensive, protecting them is of the utmost importance. To ensure their protection, the protection buffers illustrated in Appendix 18 are recommended.

Preparing for Field Work

Before starting field work, prepare and collect:

Copies of the original field sheets

Maps to show you how to get to the sample – example, 1:250 000 contour maps – and photocopies of parts of forest cover maps, which have an approximate scale of 1:20 000 and show the plot's location in detail.

Photos showing original tie points, either those used when the sample was established, or, preferably, the latest photos on which tie points and sample locations were replotted.

Equipment. See Appendix 4 for the equipment needed.

Field Training

All personnel involved in remeasurement work must attend a field procedures course.

Relocating the Plot

Checking Location and Access

The notes on the location of the plot and access to the plot usually begin with a description of an easily identifiable point.

1. Follow the access notes to the tie point.
2. Correct the notes where necessary.

The reference or tie point generally is a prominent topographic feature distinguishable on the photos and on the ground. **Examples:** a road junction, road bend, creek junction or bridge.

The blazed and/or painted tie tree should be located nearby, as described in the access notes. Aluminum sample markers were nailed to the tie tree, and strands of plastic flagging tape should still be noticeable on or near the tree.

The aluminum marker contains pertinent sample information such as:

- region number;
- compartment number;
- sample type (R);
- sample number and plot number (1 assumed);
- bearing and distance to the plot centre;
- date the sample was established.

For more information on sample markers, see Appendix 5.

New Tie Point Needed

If a new tie point is needed:

1. Select a new tie point recognizable on the photos and the ground.
2. From the map, measure and record the new bearing and distance to the plot centre.
3. Paint both sides of the tie tree in the direction of the tie line.
4. Nail an aluminum sample marker above the paint.
5. Inscribe the pertinent information on the middle and bottom sections of the 2 markers. **Note:** "Date" on the marker always refers to the date the sample was originally established. See Appendix 5.
6. Flag the tie tree with two strands of flagging tape, one above and one below the markers.
7. To aid future measurement crews, prepare a sketch showing the tie point, the sample location, and other significant topographic features. Attach the sketch to the access notes.

If you establish a new tie point, you must run a new tie line.

Checking the Tie Line

The tie line is run from the tie point with a hand compass, a clinometer and a measuring tape. When you rerun the original tie line, it is sufficient to paint the blazes, and to renew the tape markings.

Checking Corner Posts and Centre Stake

Once at the experimental plot:

1. Locate all 4 corner posts and centre stake. Each of the corners or centre was marked with a cedar post or aluminum stake driven into the ground. Sometimes cairns were built around them.
2. Check that each post is solid enough to last another 10 years. When necessary, replace a post with a tubular aluminum stake.
3. Mark each post or aluminum stake with flagging tape.

To prevent future problems locating the corners and plot centre:

1. Build a cairn around each post or stake.
2. Stem map each (unless already done) of the 4 corners and plot centre to 3 trees nearby in the plot. For each of the 4 corners and plot centre, measure:
   - the bearings to the 3 trees;
   - slope percent to the 3 trees;
   - slope distance to the 3 trees (place a nail at the centre of each tree for consistency in measuring distance).

Remeasuring the Plot and Sub-plot

Accurate work is required when you compare new measurements with previous ones. Check measurements that appear to be out of the expected range, that is measurements showing a very large increase compared with those showing little or no increase.

Correct any errors and note them in the remarks. **Example:** "dbh checked."

Converting the Breast Height in Experimental Permanent Samples

If necessary, see Appendix 21 for procedures to convert, experimental sample plots from imperial (1.37 m) to metric (1.3 m) breast height. The conversion is done only once.

Sectors in the Plot

Experimental samples are either square or rectangular in shape.

To simplify tagging, the plot was divided into sectors. Tagging started in one corner of the plot and continued up and down each sector, beginning with sector 1. Sector numbers increased toward the opposite end. The number of sectors in a plot varies among the experimental samples.

In order to aid in the choosing of top height and site trees, the plot must also be divided into 0.01 ha site sectors using the same procedure previously used - that is starting with sector 1. See Appendix 24.

Tagging Trees

Determine the breast height of trees with missing tags, as well as of ingrowth trees. Prior to 1991, breast height determination used the point of germination. Therefore, continue using point of germination.

During the remeasurements from 1980 to 1989 inclusive, the dbh height and dbh were changed to 1.3 m above germination in one of two ways (see Appendix 21). If **Method 1** was used, you will have to remove the nail at 1.3 m and replace it with the nail and tag that is at 1.37 m.

Note: If a plot is being remeasured that has not had the dbh changed from 1.37 m to 1.3 m, do it now following Method 2 in Appendix 21.

Missing Tags

For all previously measured living trees with missing tags:

1. Determine breast height at 1.3 m above germination.
2. Nail a tag which has the same tag number as the missing one.

Measuring DBH

For all **numbered living trees**, measure above the nail to the nearest millimetre, the diameter at 1.3 m.

To more accurately measure the diameter of trees that are or will soon be joined together at dbh, use the "1/2 wrap" method. To do this, measure or estimate, as accurately as you can, the diameter of each affected tree. Then, from the nail with the tag, measure half of the diameter around the bole of the tree and place a second nail. Note in the remarks that these are "1/2 wrap" measurements. In the future, the distance between the two nails will be measured and multiplied by two to arrive at the diameter of the tree.

After remeasuring the diameter:

- Pull out the nail holding the number enough to allow for tree growth until the next remeasurement.

For all **previously numbered living trees now dead**:

1. Measure the diameter above the nail at 1.3.
2. If you can't find the dead tree, assign it the same diameter as in the previous measurement. If the tree was cut down, record it as Tree Class 6 and assign the same diameter as in previous measurement.

For all **previously dead unnumbered trees that are ≥10.0 cm dbh and ≥1.3 m in height:**

1. If standing or down, collect the appropriate '*Dead tree Attributes*'. See Appendix 22.

2. If you cannot find the tree, record it as **(F)**allen.

For all **previously dead, standing, unnumbered trees that are ≥10.0 cm dbh and ≥1.3 m in height:**

1. Tag the tree with a unique number.
2. Collect the '*Dead tree Attributes*'. See Appendix 22.

Assessing whether a tree is still alive may be difficult in certain situations. Ensure that all needles/leaves are dead if the tree is being called dead, and if uncertain, err on the side of caution by calling it alive.

Classifying Trees

Classify each tagged tree according to its pathological indicators. To classify a tree properly, view it from all sides. The person measuring dbh should move far enough away from the tree to be able to classify the lower third of the stem. The recorder should move around the tree to classify the upper two thirds.

In the pathological remarks section, record each decay indicator occurring on the lower, middle or upper third of the total height of the tree. Do this by entering the correct numerical position code as follows:

Code	Position on Tree (tree is divided into thirds)
1	Lower third
2	Middle third
3	Upper third
4	Lower and middle third
5	Middle and upper third
6	Lower and upper third
7	All thirds

Tree Classes

Each tagged tree is classed in one of the following categories:

Tree Class 1: Residual;

Tree Class 2: Suspect;

Tree Class 3: Dead potential;

Tree Class 4: Dead useless;

Tree Class 5: Veteran;

Tree Class 6: Dead, cut down.

Tree Class 1: Residual

Record Tree Class 1 if:

- the tree is alive, not a veteran and free of any decay indicators.

Tree Class 2: Suspect

Record Tree Class 2 if:

- the tree is alive;
- the tree is not a veteran, and;
- the tree has one or more decay indicators.

Tree Class 3: Dead Potential

Record Tree Class 3 if:

- the tree is dead, either standing or down;
- the tree contains at least an estimated 50% of sound wood by volume, and;
- the tree is greater than or equal to 10 cm dbh and greater than or equal to 3 m in height or length.

If you can determine the tree died as a result of an insect or a disease, record the primary insect or disease responsible for the death. See Appendix 14 for damage agents and severity codes.

Tree Class 4: Dead Useless

Record Tree Class 4 if:

- the tree is dead, either standing or downed, and;
- the tree is not potentially useful. See Tree Class 3.

If you can determine the tree died as a result of an insect or a disease, record the primary insect or disease responsible for the death. See Appendix 14 for damage agents and severity codes.

Tree Class 5: Veteran

For simple stands, record Tree Class 5 if:

- a tree is at least 40 years older than the mean age of the main stand, and
- the veteran component has an estimated crown closure of less than 6% for the sample.

In complex stands, a tree is considered a veteran only when it:

- is a remnant of a much older stand;
- is at least 100 years older than the oldest sample trees of the main stand;
- has a much larger diameter than trees in the main stand. This criterion is necessary because of the subjectivity in determining what constitutes the main stand owing to the wide range of ages possible in it.

Veterans are not recognized in stands 121 years or older, except in lodgepole pine stands, which may have a veteran component of Douglas fir or larch.

Record pathological indicators for veteran trees the same way as for other trees.

Tree Class 6: Dead, Cut Down

Record Tree Class 6 if the tree is dead as a result of being cut down.

Pathological Indicators

The indicators of decay (pathological indicators) are:

Fork or Crook the result of damage to the main leader.

Scar must be weathered and may be open or closed.

Frost Crack may resemble a scar but always follows the grain.

Dead Top is a dead leader on a living tree.

Broken Top (record height to break, to the nearest metre) is a broken leader.

Conk the fruiting body of decay fungi.

Mistletoe a parasitic flowering plant.

Blind Conk pronounced swelling of depression around knots.

Rotten Branch obviously decayed large branches with a DIB of over 10 cm.

See Appendix 11 for definitions and illustrations of these pathological indicators.

The following abnormalities are not decay indicators.

- butt rot
- flute
- candelabra branch
- branch fan
- black knot
- burl and gall
- sapsucker hole
- insect boring.
- sweep
- exposed root
- spiral grain
- dry side

Assessing Damage Agents and Severity

We collect insect, disease and injury data to quantify their effect on tree growth.

For each tree affected:

1. Identify, if possible, the two most damaging agents (see Appendix 14 for damage agents and codes).
2. Assess the damage severity.
3. Record the damage agent code to a level that you are confident.
    - The damage agent codes are hierarchical and enable coding from very general (type or category) to specific (species). The first letter indicates the type of the damage while the second and third indicate the specific agent.

- If you are unable to identify the damage agent species, a short, incomplete label is still useful. **Example**: You may identify a defoliating insect and assess the percent defoliation for the tree as 30 percent. Record this as ID_30.

For the sample affected:

1. Identify the two most damaging agents in the sample.
2. Calculate the percent assessment of each agent for the sample. Determine the damage severity to the nearest one percent up to ten percent, and to the nearest five percent for severities greater than ten percent.
3. Record this assessment in the header. If known, also record the year in which the damage took place.

Assigning a Crown Class Code

Crown class refers to the position of the crown of a tree relative to all other trees within the general plot area, not the whole stand.

There are six crown classes:

1. Crown Class 1: Dominant;
2. Crown Class 2: Codominant;
3. Crown Class 3: Intermediate;
4. Crown Class 4: Suppressed;
5. Crown Class 5: Veteran;
6. Crown Class 6: Understory.

For more details on crown classes, see Appendix 12.

Assign a crown class code of 1 through 4 and 6 to each tagged tree classed as Tree Class 1, 2 or 6. For tree class 5, assign crown class 5. See "Classifying Trees" in this chapter.

Note: Crown Class 6 should be used sparingly; do not confuse it with Crown Class 4. Use Crown Class 6 only in stands 60 years or older where the understory trees, usually shade tolerant, are clearly much younger than the main stand.

Estimating Live-crown Length

Live-crown length is the distance between the treetop, if the top is alive, or from the top of the live portion, if the treetop is dead, and the base of the lowest contiguous live crown. The estimate is expressed as a percentage of the total height of the tree.

Estimate, to the nearest 10 percent, the live-crown length of all living tagged trees.

1. When determining the base of the lowest contiguous live crown, do not consider forks or epicormic branches;
2. The tops of defoliated trees may appear dead at the time of the assessment. Make sure it is or you may underestimate the live crown length.

Tagging Ingrowth Trees

The term ingrowth trees refers to commercial and non-commercial trees that were below the tagging limit during the last measurement but that now exceed that limit.

When all previously numbered trees have been remeasured, tag all commercial and non-commercial living trees now 4 cm dbh and greater, by consecutive number for the plot.

Dealing with Forked Trees

Special rules govern the tagging of forked trees:

- If the fork occurs **above 1.3 m**, tag the stem as a single tree, provided it has a dbh of at least 4 cm;
- If the fork occurs **below 1.3 m**, and two or more stems of the fork are 4 cm or greater in dbh tag each stem separately using consecutive numbers. Record, in the remarks, that these stems are forked together;
- If the fork occurs **below 1.3 m, and only one of the stems is 4 cm or greater**, tag it as a single tree.

Tagging Procedure for Ingrowth Trees

1. If a **large number of ingrowth trees** are present, use consecutive, pre-numbered blue plastic tags. If a **few trees** are present, use aluminum tags and inscribe the consecutive tree numbers for the plot.
2. Nail the tag to the tree 1.3 m above the germination point.
3. Do not use a previously used number within the plot.

Recording Data About the Sample:

For each tagged tree (4.0 cm + if alive or 10 cm + if dead) ensure that the following information is recorded:

- the tree number;
- the species;
- the tagging sector number;
- the site sector number;
- the dbh;
- the tree class;
- any pathological indicators or dead tree attributes;
- the crown class (living trees only);
- suitability for height measurement, (Y)es, (N)o, (C)ould be, (F)lagged, (V)ery difficult to measure, (E)asy to measure;
- the live-crown length;
- pest or injury codes, if applicable;
- the tree number of the closest, previously numbered living tree (if ingrowth).

The data must be captured digitally in the field with an Electronic Field Recorder (EFR) using Gyhost/Gyhand software (see "Gyhost/Gyhand: A Data Collecting, Editing

and Reporting System" on the Ministry's Web page. In case of emergency (i.e. EFR breaks down) the data may be collected on field sheets and then later entered into the Gyhost/Gyhand system. For information on how to fill out the field sheets, see "Completing the Field Sheets" in Appendix 16. See Appendix 19 for a copy of the "Growth Sample Record Sheet".

Note: Previously classified trees that are now considered to be shrubs must be dropped (code "D" for drop) from the sample and tags removed.

Sub-plot and Tree Count

To have some representation from trees below the plot tagging limit, a circular sub-plot was established with its centre at the intersection of diagonals from the corner posts. The objective was to obtain a minimum of 20 living commercial trees that were less than the plot tagging limit but at lease 0.3 m in height. The sub-plot size was selected from Appendix 6. However, the sub-plot radius was less or equal to one-half the length of the shortest side of the rectangle even if less than 20 stems were obtained.

The centre was marked with an aluminum tubular stake. A plot centre tree close to the aluminum stake was selected and marked with aluminum markers.

If the plot centre tree is missing, whether from natural causes or not:

1. Select another centre tree near the plot centre.
2. Mark it properly. Nail two aluminum plot markers approximately 2 metres above the ground.
3. Inscribe the following information on the markers:
   - sample type (R);
   - sample number;
   - plot number (1 assumed);
   - region number;
   - compartment number;
   - the original date the plot was established.
4. Mark the centre tree with two strands of plastic flagging tape, one above and one below the aluminum markers.

If the centre tree is present but its markers are missing or illegible, replace them.

If the stake was pulled out, the bearing and distance from the centre stake to 3 trees nearby were recorded. Use this information to relocate the centre stake.

Within the sub-plot, all living commercial trees **2 cm dbh and greater but less than the plot tagging limit** were tagged using one of two methods. See "Tagging Trees" in this chapter.

Trees of commercial species **less than 2 cm dbh but 0.3 m in height** had their tags wired either to a branch or to the main stem. These tags and wires should be removed, if possible, to prevent girdling the stems.

Measuring Sub-plot Trees

For trees 2 cm dbh and greater previously tagged within the sub-plot, use the same method as in the main plot. See "Tagging Trees" in this chapter.

Attach a number tag to the tree with a nail at breast height (1.3 m) if the tree:

- was less than 2 cm dbh during the last measurement;
- now has a dbh of 2 cm or greater, and;
- is a commercial species.

Include the tree in the dot count if the tree:

- is less than 2 cm dbh, and;
- is a commercial species.

Special rules govern the tagging of forked trees at least 2 cm dbh but less than 4 cm dbh within the sub-plots:

- If the fork occurs above 1.3 m, tag the stem as a single tree;
- If the fork occurs below 1.3 m, tag each fork as a tree provided each is 2 cm dbh and greater.

Gathering and Recording Information about Sub-plot Trees

Trees 2 cm dbh and greater:

For each tree 2 cm dbh and greater in the sub-plot, record the following:

- the tree number;
- the species;
- the tagging sector number;
- the site sector number;
- the dbh;
- the tree class;
- any pathological indicators;
- the crown class;
- the live-crown length;
- damage agent codes, if applicable;
- suitability for height measurement (Y)es, (N)o, (C)ould be, (F)lagged, (V)ery difficult to measure, (E)asy to measure;
- the number of the closest previously tagged plot living tree.

Trees less than 2 cm dbh:

Count trees less than 2 cm dbh in a dot tally and record them:

- as dbh class 0 or 1 (see Table 1 below)
- by species. See Appendix 3.

Table 1 Metric dbh Classes and Limits

dbh class	Limits
0	0.3 m to 1.3 m high
1	0.1 cm to 1.9 cm dbh

Forked trees less than 2 cm dbh:

Give special attention to the method of counting forked trees less than 2 cm dbh. For example: To avoid counting numerous leaders of trees that have been severely browsed, count only the tallest leader. See Appendix 10 for a further explanation.

Unusual trees:

Now and then, you will find unusual live trees within the sub-plot. Special rules apply when measuring the height of abnormal trees less than 2.0 cm dbh. See Appendix 10.

Determining the Stand Structure

Stand structure is the physical arrangement or pattern of organisation of the stand. Stand structure is described and classified according to recognizable age and height differences.

The recognized stand structures are:

1. Single layer, simple stands (even age and height)
    - with veterans
    - without veterans
2. Single layer, complex stands (uneven age and height)
    - with veterans
    - without veterans
3. Multi layer stands
    - layer 1 is the top layer
    - layer 2 is the bottom layer

For single layer stands, layer 1 is assumed for trees in the main stand and tree class 5 identifies the veteran layer.

For multi layer stands, record 1 for the top layer trees and 2 for the bottom layer. The sample primary layer, according to regional priorities, must be identified.

For further details on stand structure, see Appendix 13.

Height Sample Trees

Local height-diameter curves are constructed from sample data before compiling samples.

To construct reliable curves, a substantial number of heights is needed for each species. The number depends on the stand composition, which ultimately is based on basal area. In the field, use the calculated basal area for stand composition.

Top Height

Select the top height tree from a 0.01 ha circular plot at plot centre. Record "C" (centre sector) for the tree. Top height (1998) is the height of the largest diameter tree, regardless of species, in a 0.01 ha plot, providing the tree is suitable. A suitable tree must be healthy, not have a broken or damaged top, not have its height growth affected by a competitor nor be a residual left from previous logging. There is no substitution for an unsuitable tree.

If the PSP is one selected for SIBEC, select the largest diameter tree of each additional species in the 0.01 ha circular plot at plot centre, and record "C" (centre sector) for the tree.

For a single-layered stand, or for each layer in a multi-layered stand, select height sample trees as follows:

First Two Major Species

For each of the first two major species (20 percent or more by composition), select trees for the sample as follows:

1. Select the required number of site trees on the basis of the largest diameter living tree per 0.01 ha plot or sector, to a maximum of ten. In the case of a sample larger than 0.1 ha, randomly select ten site sectors and take the site trees from them - do not substitute. In future remeasurements, the same sector numbers will be used to choose site trees.

   Suitable site trees have the following characteristics:
   - free of major defects;
   - crown class of 1 or 2. The exception is in the case of the second layer in a two-layer stand where crown class 3 and 4 are acceptable;
   - cannot be substituted.

   Example: On a 0.1 hectare sample, the ten largest dbh trees from each of the two leading major species are selected for site tree measurements. Similarly, four trees would be selected in a 0.04 hectare sample.

2. Select an additional 15 trees distributed evenly across the remaining dbh range, down to 2 cm dbh.

For Third and Fourth Majors, Minor and Scattered Species

For the third and fourth major species (20 per cent or greater by composition), each minor species (10 to 19 percent by composition) and for scattered species (less than 10 percent by composition), select 15 trees, if present and suitable. Distribute them across the dbh range, down to 2 cm dbh. Place emphasis on larger diameter classes.

For Veterans

For the veteran layer:

1. Select one sample tree from each species present.
2. Estimate the height of all others.
3. Record the estimated height of all the veterans in the small tree or Vet height section.

Remeasuring Heights Consistently

To ensure future height measurements are taken consistently from the same direction, paint a blue dot, if not already done, at dbh to indicate the direction from which the height measurement was taken.

Ensure that height sample trees previously taken are remeasured for height and from the same direction as indicated by the blue painted dot (unless no longer suitable) even if the resultant distribution over the dbh classes is not optimum. If possible, strive for the full range of diameters down to 2.0 cm dbh.

Selecting Sample Trees

When possible, select residual trees (Tree Class 1). See "Classifying Trees" in this chapter. Otherwise, select trees that do not have major suspect characteristics, such as a major fork, which affects the true height or a major scar at breast height which affects its true diameter.

Do not select trees with:

- diameters that were estimated;
- sweeps or leans greater than 5 degrees.

In some areas, it may be impossible to meet sample height requirements if only suitable trees as described above are taken. In this situation, take the best of the "poor" trees to meet the requirement. However, do not select a tree if its height is less than 95% of what it would be without its defect – lean, fork, broken top, etc.

Measuring Suppressed Trees with Flattened Tops

To ensure accurate measurements of suppressed trees:

1. Sight on the highest point of the top.
2. For hemlock trees, sight on the highest point of the droop.
3. For cedar trees, make sure you take the top reading on the tiny leader and not on a lateral branch, which may be higher.

Age Sample Trees

Note: If the present top height and site trees had their ages taken at 1.3 m during the last measurement, no further ages are required. If the top height tree or any tree of first and second leading major species do not have an age at 1.3 m, it must be taken now and recorded in the "New Age" field.

In **single layer, simple stands,** pure and mixed, the age of the stand is determined by averaging the ages of the site trees of the leading major species in the sample. However, ages of the site trees of the second major species must also be taken.

The sample mean age is derived from the site trees of the leading species only, even if some of their cores are rotten. The rotten portion must be estimated to derive a total age for the tree. See "Counting Rings on Rotted Cores" in this chapter.

Bore trees that appear to be veterans to confirm they are in fact veterans. Bore the smallest diameter veteran per species only; the others can be assumed to be veterans too. Use these ages for the veteran layer.

In **single layer, complex stands**, the average age of the stand is determined from the ages of the site trees of the leading major species. However, to show the variation of the stand's age, take two additional ages of the leading major species from the younger portion of the stand. Treat the second major species the same as the leading.

In **multi layer stands**, select sample trees, as outlined above, for each layer.

Taking the Age of a Tree

1. Bore the selected trees at 1.3 m.
2. Remove the core. Make sure two cores per species include the pith.
3. If the core includes the pith, record "Y" in the pith field.
4. Rebore the tree if you missed the pith by more than an estimated:
   - 2 years on a tree younger than 100 years, or;
   - 2 percent on a tree older than 100 years.
5. While in the field, count the rings on the core and record the count.
6. Measure and record the radial increment for the last 5, 10 and 20 years.
7. Measure and record the evidence of suppression, if any. See Appendix 23.
8. Place the cores in plastic straws with the following information:
9. Place the cores in plastic straws with the following information:
   - the region number, R#;
   - the compartment number, Co#;
   - the sample number, R#;
   - tree number;
   - species;
   - counted age.

Counting Rings on Rotted Cores

If the sample tree has rotten portions:

1. Count the rings on the sound portion of the core.
2. Estimate the number of years in the rotten portion.
3. Add the number of years in the sound portion to the estimated number of years in the rotten portion.
4. Record the total breast-height age, with an (**R**)otted for pith.

Estimating Other Plot Attributes

Estimating Crown Closure

Crown closure is the percentage of ground area covered by the vertically projected crowns of trees.

For each plot, estimate and record the crown closure by layer to the nearest 10%.

For the veteran component of the plot, record crown closure to the nearest percent. If the crown closure of the veteran component for the sample is six percent or more, it must be classified as a separate layer.

Determining Elevation

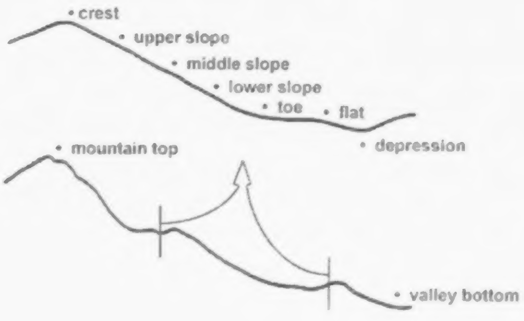
Determine and record the elevation of each plot if not already done.

Determining Aspect and Slope

Determine the aspect and slope for each plot if not already done.

Determining Slope Position

Slope position is the relative position of the plot within a water catchment area. Determine the slope position and record the appropriate code:

Code	Category	Slope Position
C	Crest	 crest upper slope middle slope lower slope toe flat mountain top depression valley bottom
U	Upper	
M	Mid	
L	Lower	
T	Toe	
F	Flat (level)	
D	Depression	

Collecting Ecological Data

All samples established in natural stands are ecologically assessed. If not already done, collect and record ecological data to the Biogeoclimatic Ecosystem Classification (BEC) site series level. See Appendix 25. If it is not possible to collect the ground data at the time of measurement, at minimum, obtain the BEC Zone, Sub-Zone, and Variant.

Quality Assurance

Sampling crews should emphasize accuracy over production. For the standards of measurement, see Appendix 1.

Checking Sampling Crews

To ensure crews follow and understand recommended procedures, carry out regular inspections.

1. Inspect at least 10 percent of all samples remeasured. If the sample has been poorly done, the original crew may be required to redo it.
2. Make spot checks as work progresses to be sure tie points and tie lines are properly marked.
3. To observe sampling crew performance, occasionally visit each crew on the sample.

Checking the Samples in the Office

All samples must be inspected in the office before sending them to the Vegetation Resources Inventory Section of the Terrestrial Information Branch. Ensure that:

1. The sample identification is correct and valid.
2. The sample header is as complete as possible.
3. The number and distribution of tree heights – both top height and others – were met.
4. The required number of ages and piths were met.
5. The access notes are complete and include the tie point sketch.

Inspecting the Sample

Once the samples have been checked in the office, randomly select one of the samples and conduct the following:

- a pre-field inspection;
- a field inspection;
- a post-field inspection.

Pre-field Inspection

1. Randomly select one sample from the ones checked in the office.
2. Enter the following information in the section at the top of the plot inspection report:
    - the sample identification – region, compartment, sample, sample type and plot;
    - the plot and sub-plot sizes;
    - the length of plot sides and sub-plot radii;
    - the inspection date;
    - the original tally crew;
    - the measurement date.
3. Randomly select 7 live and 2 dead trees from the tree detail section.

4. Transcribe the measurements of the 7 live and 2 dead trees to the top section of the plot inspection report. See Appendix 15.
5. Randomly select 5 trees for height from the sample tree section.
6. Transcribe the height measurements of the 5 trees to the sample tree section of the plot inspection report.
7. Select two age cores and check the age count as well as the suppression readings.
8. Transcribe the crown closure, aspect, slope and slope position of the plot to the appropriate section of the plot inspection report.
9. From the tree count summary section, randomly select one diameter class for a species. Later, you will use this diameter class in the field to check that the dot tally is correct for that class.

Note: Steps 2 to 9 are automatically done on the Gyhost/Gyhand Data Capture and Reporting System. Select the quality assurance report for printing.

Field Inspection

1. Use the access notes to get to the sample and verify their accuracy and completeness.
2. If a new tie tree was selected on remeasurement, check that it was marked as specified in "Checking the Tie Point" in this chapter.
3. If a new tie line was run, verify that the bearing and distance were run within the allowable standards.
4. Check that the plot centre markers were inscribed correctly and the plot centre stake was properly protected with a cairn.
5. Check the plot sides and the sub-plot radius at a minimum of three different locations. Look for ingrowth trees that should have been included or excluded from the plot or sub-plot. Flag with a circled asterisk any tree missed or mistakenly tallied.
6. Check that all sub-plot trees less than 4 cm dbh but at least 0.3 m in height were either tagged or counted in the dot tally.
7. Carefully measure all the trees you selected during the pre-field inspection:
   - **Tree Identification** – Check that the genus or species of each tree inspected is correct. If not, place a circled asterisk beside the tree;
   - **Tree tag height** – Check the tag height of the selected ingrowth trees to verify that breast heights, if applicable, were located at 1.3 m above the germination point. At the same time, make sure the nails were securely driven into the trees and the nail with the tag was driven in at a slight angle so that the tag hangs away from the tree;
   - **Diameter and pathological remarks** (decay indicators) – Measure the 7 live and 2 dead selected trees and classify them;
   - **Sample tree heights** – Measure the 5 selected trees for height;
   - **Stem mapping** – If the sample was stem mapped, check the 7 selected trees for bearing, distance and percent slope.
8. Assess the crown closure for the plot.
9. Compare your measurements with the previous ones giving the crew the benefit of the doubt.

10. Check that the results conform to the standards of measurement. See Appendix 1.
11. If the difference between two measurements is greater than the allowable error, place an asterisk in the margin.
12. If the error is greater than two times the allowable error, circle the asterisk.
13. Complete the inspection items section of the inspection report.
14. Rate the quality of the work on the plot using the weighted system in Appendix 2.
15. Record your rating of the plot and any other comments in the remarks section of the plot inspection report.

Post-Field Inspection

1. Discuss the results of your inspection with the original field crew.
2. Make recommendations to the original field crew, if necessary, on how to improve their work.
3. Correct the original data changing all the data that was flagged with an asterisk or a circled asterisk in your inspection report.

Damage to the Sample and Returning the Samples

Damage to the Experimental Plot

Damage to samples can result from natural or artificial causes.

1. If the sample was damaged by natural causes such as slides, snow, fungi, insects, disease and fire, it should be remeasured if at least 25% of the plot trees are still living.
2. If the sample was damaged (disturbed) by artificial means, refer to "Guidelines for Deciding if Damaged Permanent Plots Should be Remeasured" in Appendix 20.

If a sample is to be destroyed:

1. Remeasure it one last time if at least three years have elapsed since the last measurement.
2. Classify it ecologically.
3. Make sure the plot centre can be relocated after logging so that the long-term productivity effects can be determined.

Returning the Samples

Once the samples are checked in the office and corrected:

1. Send a list of all the samples, any original field sheets, the electronic download from the GyHost as well as a hard copy of reports 1,2,3,5,6 and 7 to the Vegetation Resources Inventory Section of the Terrestrial Information Branch.
2. Keep a copy of all the above for security and reference.

4. Remeasurement of Permanent Sample Plots in Silviculturally Treated Stands

Introduction

Samples in silviculturally treated stands are remeasured every ten years. This interval should be maintained whenever possible. A list of samples with their establishment and remeasurement dates and map locations is regularly circulated to the regions so that remeasurement can be planned in advance.

The standards of measurement for permanent samples are listed in Appendix 1.

If not already done, ecologically classify, according to Research Branch specifications, all samples due for remeasurement.

Since permanent samples are cost intensive, protecting them is of the utmost importance. To ensure their protection, the protection buffers illustrated in Appendix 18 are recommended.

Preparing for Field Work

Before field work starts, prepare and collect:

Copies of the original field sheets

Maps to show you how to get to the sample – example, 1:250 000 contour maps – and photocopies of parts of forest cover maps, which have an approximate scale of 1:20 000 and show the plot's location in detail.

Photos showing original tie points, either those used when the sample was established, or, preferably, the latest photos on which tie points and sample locations were replotted.

Equipment. See Appendix 4 for the equipment needed.

Field Training

All personnel involved in remeasurement work must attend a field procedures course.

Relocating the Plot

Checking Location and Access

The notes on the location of the plot and access to the plot usually begin with a description of an easily identifiable point.

1. Follow the access notes to the tie point.
2. Correct the notes where necessary.

The reference or tie point generally is a prominent topographic feature distinguishable on the photos and on the ground. **Examples:** a road junction, road bend, creek junction or bridge.

The painted tie tree should be located nearby, as described in the access notes. Aluminum sample markers are usually nailed to the tie tree, and strands of plastic flagging tape should still be noticeable on or near the tree.

The aluminum marker contains pertinent sample information such as:

- region number;
- compartment number;
- sample type (T);
- sample number and plot number (usually 1, but 3-plot samples exist);
- bearing and distance to the plot centre;
- date the sample was established.

For more information on sample markers, see Appendix 5.

New Tie Point Needed

If a new tie point is needed:

1. Select a new tie point recognizable on the photos and the ground.
2. From the map, measure and record the new bearing and distance to the plot centre.
3. Paint both sides of the tie tree in the direction of the tie line.
4. Nail an aluminum sample marker above the paint.
5. Inscribe the pertinent information on the middle and bottom sections of the 2 markers. **Note:** "Date" on the marker always refers to the date the sample was originally established. See Appendix 5.
6. Flag the tie tree with two strands of flagging tape, one above and one below the markers.
7. To aid future measurement crews, prepare a sketch showing the tie point, the sample location, and other significant topographic features. Attach the sketch to the access notes.

If you establish a new tie point, you must run a new tie line.

Checking the Tie Line

The tie line is run from the tie point with a hand compass, a clinometer and a measuring tape. When you rerun the original tie line, it is sufficient to renew the paint and the tape markings.

Checking the Centre Tree

Each established plot has a centre tree marked with aluminum markers and strands of flagging tape. The markers and tape are usually secured about two metres above ground to avoid interfering with dbh measurements. If the centre tree is missing, either because of natural causes or because somebody cut it down:

1. Select another centre tree near the plot centre.

2. Mark it with the two aluminum markers and flagging tape.

Checking the Plot Centre Tree Markers

Missing or Illegible Plot Markers

Discovering missing or illegible plot centre tree markers is not unusual. Here's how to proceed:

1. Replace the old markers. Centre tree markers are the same as those used for tie point trees. See Appendix 5.
2. Complete the top and bottom sections of the markers. Include the following information:
   - sample type (T);
   - sample number;
   - plot number;
   - region number;
   - compartment number;
   - date the plot was established.

When the Plot Centre is also a Tie Point

Sometimes the plot centre also serves as a tie point for the next plot on the tie line. When it is, the middle section of the marker should also be filled out.

Checking the Plot Centre Stake

The plot centre is marked by a tubular aluminum stake, either driven into the ground or supported by a cairn on rocky ground. You can usually identify the stake by the flagging tape on it. If the plot centre stake location has never been stem mapped, select three trees around the plot centre, and record the bearing, slope, and distance from the plot centre stake to the centre of each tree. Place a nail at the centre of each tree for consistency in measuring distance to the centre stake.

Replace the plot centre stake if the stake is:

- missing;
- pulled out but lying on the ground;
- bent but still in the original location.

Replacing a bent stake is not difficult because it's still stuck in the ground. For a stake found lying on the ground, you may locate its original position by simply looking around for signs of the plot centre location.

In Case the Stake is Missing

Unless the centre stake location was stem mapped, relocating a missing plot centre stake is a difficult, time-consuming, but necessary task.

If the centre stake location was not stem mapped:

1. Tally the original trees on the plot before relocating the centre stake. Some tags may be down or missing, so replace them before relocating the centre stake.
2. Determine the approximate centre by observing the layout of the sectors.
3. Find trees close to the plot perimeter and measure the plot radius from those trees until you determine the approximate plot centre. Using the 'approximate plot centre' and the plot radius as a starting point, check that all tagged trees are in the plot. If not, adjust the plot centre until they are.
4. If not already done, build a cairn around the newly relocated plot centre stake.
5. Measure the bearing, slope percent, and slope distance from the plot centre to 3 trees nearby. Place a nail at the centre of each tree for consistency in measuring distance to the centre stake.
6. In sample remarks, record that the centre stake was missing.

Remeasuring the Plot

Accurate work is required when you compare new measurements with previous ones. Always position the dbh tape just above the nail and perpendicular to the bole of the tree. Check measurements that appear to be out of the expected range; that is, measurements showing a very large increase compared with those showing little or no increase.

Correct any errors and note them in the remarks. **Example**: "dbh checked."

Sectors in the Plot

Plots were generally divided into eight tagging sectors with number one starting clockwise from the direction of the original tie line or, in later years, from the north. In order to aid in the choosing of top height and site trees, the plot must also be divided into 0.01 ha site sectors using the same procedure previously used; that is, starting clockwise from the direction of the original tie line or from the north. See Appendix 24.

Tagging Trees

Determine the breast height of trees with missing tags, as well as of ingrowth trees. In 1991, breast height determination changed from using the point of germination to using the base of the tree on the uphill side. Therefore:

- for samples established **before 1991**, continue using the point of germination;
- for samples established from **1991**, use the base of the tree on the uphill side.

Missing Tags

For all previously measured living trees with missing tags:

1. Determine breast height at 1.3 m above germination, or 1.3 m above the base of the tree on the uphill side for samples established after 1990.
2. Nail a tag which has the same tag number as the missing one.

Finding Missing Tags

During the establishment, tagging began near the centre in sector 1 and continued in a zigzagging pattern toward the circumference with the tags facing the plot centre. Once all taggable trees in sector 1 were tagged, the procedure was repeated in sector 2, only this time tagging began at the circumference with the tags facing away from the plot centre. The procedures for tagging sectors 1 and 2 were repeated alternately for all remaining sectors of the plot.

Measuring DBH

For all **numbered living trees**, measure above the nail, to the nearest millimetre, the diameter at 1.3 m.

To more accurately measure the diameter of trees that are or will soon be joined together at dbh, use the "1/2 wrap" method. To do this, measure or estimate, as accurately as you can, the diameter of each affected tree. Then, from the nail with the tag, measure half of the diameter around the bole of the tree and place a second nail. Note in the remarks that these are "1/2 wrap" measurements. In the future, the distance between the two nails will be measured and multiplied by two to arrive at the diameter of the tree.

After remeasuring the diameter:

- Pull out the nail holding the number enough to allow for tree growth until the next remeasurement.

For all **previously numbered living trees now dead**:

1. Measure the diameter above the nail.
2. If you can't find the dead tree, assign it the same diameter as in the previous measurement. If the tree was cut down, record it as Tree Class 6 and assign the same diameter as in the previous measurement.

For all **previously dead unnumbered trees that are ≥10.0 cm dbh and ≥1.3 m in height**:

1. If standing, collect the '*Dead tree Attributes*'.
2. If down, or you cannot find, record it as (**F**)allen.

For all **previously dead unnumbered trees that are ≥10.0 cm dbh and ≥1.3 m in height**:

1. Tag the tree with a unique number.
2. Collect the *'Dead tree Attributes'*.

Classifying Trees

Classify each tagged tree according to its pathological indicators.

To classify a tree properly, view it from all sides. The person measuring dbh should move far enough away from the tree to be able to classify the lower third of the stem. The recorder should move around the tree to classify the upper two thirds.

Record each pathological indicator as occurring on the lower, middle or upper third of the total height of the tree. Do this by entering the following Pathological (Decay) Indicator Position Codes:

Code	**Position on Tree** (tree is divided into thirds)
1	Lower third
2	Middle third
3	Upper third
4	Lower and middle third
5	Middle and upper third
6	Lower and upper third
7	All thirds

Tree Classes

Each tagged tree is classed in one of the following categories:

1. Tree Class 1: Residual;
2. Tree Class 2: Suspect;
3. Tree Class 3: Dead potential;
4. Tree Class 4: Dead useless;
5. Tree Class 5: Veteran;
6. Tree Class 6: Dead, cut down.

Tree Class 1: Residual

Record Tree Class 1 if:

- the tree is alive, not a veteran and free of any decay indicators.

Tree Class 2: Suspect

Record Tree Class 2 if:

- the tree is alive;
- the tree is not a veteran, and;
- the tree has one or more decay indicators.

Tree Class 3: Dead Potential

Record Tree Class 3 if:

- the tree is dead, either standing or down;
- the tree contains at least an estimated 50% of sound wood by volume, and;
- the tree is greater than or equal to 10 cm dbh and greater than or equal to 3 m in height or length.

If you can determine the tree died as a result of an insect or a disease, record the primary insect or disease responsible for the death. See Appendix 14 for damage agents and severity codes.

Tree Class 4: Dead Useless

Record Tree Class 4 if:

- the tree is dead, either standing or down;
- the tree is not potentially useful. See Tree Class 3.

If you can determine the tree died as a result of an insect or a disease, record the primary insect or disease responsible for the death. See Appendix 14 for damage agents and severity codes.

Tree Class 5: Veteran

For simple stands, record Tree Class 5 if:

- a tree is at least 40 years older than the mean age of the main stand;
- the veteran component has an estimated crown closure of less than 6% for the sample.

In complex stands, a tree is considered a veteran only when it:

- is a remnant of a much older stand;
- is at least 100 years older than the oldest sample trees of the main stand;
- has a much larger diameter than trees in the main stand. This criterion is necessary because of the subjectivity in determining what constitutes the main stand owing to the wide range of ages possible in it.

Veterans are not recognized in stands 121 years or older, except in lodgepole pine stands, which may have a veteran component of douglas fir or larch.

Record pathological indicators for veteran trees the same way as for other trees.

Tree Class 6: Dead, Cut Down

Record Tree Class 6 if the tree is dead as a result of being cut down.

Pathological Indicators

The eight indicators of decay (pathological indicators) are:

Fork or Crook the result of damage to the main leader.

Scar must be weathered and may be open or closed.

Frost Crack may resemble a scar but always follows the grain.

Dead or Broken Top broken or dead leader.

Conk the fruiting body of decay fungi.

Mistletoe is a parasitic flowering plant.

Blind Conk pronounced swelling of depression around knots.

Rotten branch obviously decayed large branches with a DIB of over 10 cm.

See Appendix 11 for definitions and illustrations of these pathological indicators.

The following abnormalities are not pathological indicators.

- butt rot
- flute
- candelabra branch
- branch fan
- black knot
- burl and gall
- sapsucker hole
- insect boring
- sweep
- exposed root
- spiral grain
- dry side

Assessing Damage Agents and Severity

We collect insect, disease and injury data to quantify their effect on tree growth.

For each tree affected:

1. Identify, if possible, the damage agent (see Appendix 14 for damage agents and codes).
2. Assess the damage severity.
3. Record the primary damage agent code to a level that you are confident.
    - The damage agent codes are hierarchical and enable coding from very general (type or category) to specific (species). The first letter indicates the type of the damage while the second and third indicate the specific agent.
    - If you are unable to identify the damage agent species, a short, incomplete label is still useful. **Example**: You may identify a defoliating insect and assess the percent defoliation for the tree as 30 percent. Record this as ID_30.

For the sample affected:

1. Identify the primary damage agent in the sample;
2. Make a general percent assessment of the agent for the sample;
3. Record this assessment in the header. If known, also record the year in which the damage took place.

Assigning a Crown Class Code

Crown class refers to the position of the crown of a tree relative to all other trees within the general plot area, not the whole stand.

There are six crown classes:

1. Crown Class 1: Dominant;
2. Crown Class 2: Codominant;
3. Crown Class 3: Intermediate;
4. Crown Class 4: Suppressed;
5. Crown Class 5: Veteran;

6. Crown Class 6: Understory.

For more details on crown classes, see Appendix 12.

Assign a crown class code of 1 through 4 and 6 to each tagged tree classed as Tree Class 1, 2. For tree class 5, assign crown class 5. See "Classifying Trees" in this chapter.

Note: Crown Class 6 should be used sparingly; do not confuse it with Crown Class 4. Use Crown Class 6 only in stands 60 years or older where the understory trees, usually shade tolerant, are clearly much younger than the main stand.

Estimating Live-crown Length

Live-crown length is the distance between the treetop, if the top is alive, or from the top of the live portion, if the treetop is dead, and the base of the lowest contiguous live crown. The estimate is expressed as a percentage of the total height of the tree.

Estimate, to the nearest 10 percent, the live-crown length of all living tagged trees.

- When determining the base of the lowest contiguous live crown, do not consider forks or epicormic branches;
- The tops of defoliated trees may appear dead at the time of the assessment. Make sure it is or you may underestimate the live-crown length.

Tagging Ingrowth Trees

The term ingrowth trees refers to commercial and non-commercial trees that were below the tagging limit during the last measurement but that now exceed that limit.

When all previously numbered trees have been remeasured, tag all commercial and non-commercial living trees that are $\geq$ 4.0 cm. by consecutive number for the plot.

Dealing with Forked Trees

Special rules govern the tagging of forked trees:

- If the fork occurs **above 1.3 m**: Tag the stem as a single tree, provided it has a dbh of at least 4 cm;
- If the fork occurs **below 1.3 m**, and two or more stems of the fork are 4 cm or greater in dbh: Tag each stem separately using consecutive numbers. Record, in the remarks, that these stems are forked together;
- If the fork occurs **below 1.3 m, and only one of the stems is 4 cm or greater**: Tag it as a single tree.

Tagging Procedure for Ingrowth Trees

1. If a large number of ingrowth trees are present, use consecutive, pre-numbered blue plastic tags. If few trees are present, use aluminum tags and inscribe the consecutive tree numbers for the plot.
2. Nail the tag to the tree 1.3 m above the germination point—or above the base of the tree on the uphill side, for samples established after 1990.

3. Do not use previously used numbers within the plot.
4. Record:
    - the tree number;
    - the species;
    - the tagging sector number;
    - the site sector number;
    - the dbh;
    - the tree class;
    - any pathological indicators;
    - the crown class;
    - the live-crown length;
    - damage agent codes, if applicable;
    - the tree number of the closest, previously numbered living tree.

For plots in dense stands, string the plot circumference beforehand.

Remeasuring the Sub-plot

To have some representation from trees below the tagging limit, a sub-sample was established for each sample. The objective was to obtain a total of 20 living commercial trees that were less than the plot tagging limit but at least 0.3 m in height. These trees were tagged with a nail if 2.0 cm dbh and greater; if less, the tag was wired onto either a branch or the main stem. These tags and wire should be removed, if possible, to prevent girdling of the stems.

Note: Some silviculturally treated samples were established shortly after spacing or thinning took place. In order to meet the minimum requirement of stems less than the tagging limit, a large sub-plot size may have been used. If this same sub-plot is used now, ten years later, it could mean an excessive number of sub-plot trees.

Therefore, a one time change during **measurement one** in sub-plot size is allowed. Choose a sub-sample size from Appendix 8 that will yield 20 commercial stems in the sample that are less than the tagging limit but at least 0.3 m in height.

Notice of this change and the new sub-plot radius must be entered in the sample remarks section. Also, any previously tagged sub-plot tree that is now outside the new sub-plot must be “dropped” in screen #106 of the GyHand.

Gathering & Recording Information About Sub-plot Trees

Trees of commercial species 2 cm dbh and greater:

For each tree 2 cm dbh and greater in the sub-plot, record the following:

- the measurement number;
- the tree number;
- the species;
- the tagging sector number;
- the site sector number;

- the dbh;
- the tree class;
- any pathological indicators;
- the crown class;
- the live-crown length;
- damage agent codes, if applicable;
- suitability for height measurement, (Y)es, (N)o, (C)ould be, (F)lagged, (V)ery difficult to measure; (E)asy to measure;
- the number of the closest previously tagged plot living tree.

Trees of commercial species less than 2 cm dbh:

Count trees less than 2 cm dbh in a dot tally and record them:

- as dbh class 0 or 1. See Table 1 below
- by species. See Appendix 3.

Table 1. Metric dbh Classes and Limits

dbh Class	Limits
0	0.3 m to 1.3 m high
1	0.1 cm to 1.9 cm dbh

Forked Trees Less than 2 cm dbh:

Gives special attention to the method of counting forked trees less than 2 cm dbh. **Example:** To avoid counting numerous leaders of trees that have been severely browsed, count only the tallest leader. See Appendix 10 for a further explanation.

Unusual Trees:

Now and then, you will find unusual live trees within the sub-plot. Special rules apply when measuring the height of abnormal trees less than 2.0 cm dbh See Appendix 10.

Determining the Stand Structure

Stand structure is the physical arrangement or pattern of organization of the stand. Stand structure is described and classified according to recognizable differences in age and in height.

The recognized stand structures are:

1. Single layer, simple stands (even age and height)
    - with veterans;
    - without veterans.
2. Single layer, complex stands (uneven age and height)
    - with veterans;
    - without veterans.

3. Multi layer stands
    - layer 1 is the top layer;
    - layer 2 is the bottom layer.

For single layer stands, layer 1 is assumed for trees in the main stand and tree class 5 identifies the veteran layer.

For multi layer stands, record 1 for the top layer trees and 2 for the bottom layer. The sample primary layer, according to regional priorities, must be identified.

For further details on stand structure, see Appendix 13.

Height Sample Trees

Local height-diameter curves are constructed from sample data before compiling samples.

To construct reliable curves, a substantial number of heights is needed for each species. The number depends on the stand composition which ultimately is based on basal area. In the field, use the calculated basal area for stand composition.

Top Height

Select the top height tree from the site sector one. Top height (1998) is the height of the largest diameter tree, regardless of species, in a 0.01 ha plot, providing the tree is suitable. A suitable tree must be healthy, not have a broken or damaged top, not have its height growth affected by a competitor nor be a residual left from previous logging. There is no substitution for an unsuitable tree.

For a single-layered stand, or for each layer in a multi-layered stand, select height sample trees as follows:

First Two Major Species

For each of the first two major species (20 percent or more by composition), select trees for the sample as follows:

1. Select the required number of site trees on the basis of the largest diameter living tree per 0.01 ha plot or sector, to a maximum of ten. In the case of a sample larger than 0.1 ha, randomly select ten site sectors and take the site trees from them - do not substitute. In future remeasurements, the same sector numbers will be used to choose site trees.

    Suitable site trees have the following characteristics:
    - free of major defects;
    - crown class of 1 or 2. The exception is in the case of the second layer in a two-layer stand where crown class 3 and 4 are acceptable;
    - cannot be substituted.

    Example: On a 0.1 hectare sample, the ten largest dbh trees from each of the two leading major species are selected for site tree measurements. Similarly, four trees would be selected in a 0.04 hectare sample.

2. Select an additional 15 trees distributed evenly across the remaining dbh range, down to 2 cm dbh.

For Third and Fourth Majors, Minor and Scattered Species

For the third and fourth major species (20 per cent or greater by composition), each minor species (10 to 19 percent by composition) and for scattered species (less than 10 percent by composition), select 15 trees, if present and suitable. Distribute them across the dbh range, down to 2 cm dbh. Place emphasis on larger diameter classes.

For Veterans

For the veteran layer:

1. Select one sample tree from each species present.
2. Estimate the height of all others.
3. Record the estimated height of all the veterans in the small tree or Vet height section.

Remeasuring Heights Consistently

To ensure future height measurements are taken consistently from the same direction, paint a blue dot, if not already done, at dbh to indicate the direction from which the height measurement was taken.

Ensure that height sample trees previously taken are remeasured for height and from the same direction as indicated by the blue painted dot (unless no longer suitable) even if the resultant distribution over the dbh classes is not optimum. If possible, strive for the full range of diameters down to 2 cm dbh.

Selecting Sample Trees

When possible, select residual trees (Tree Class 1). See "Classifying Trees" in this chapter. Otherwise, select trees that do not have major suspect characteristics, such as a major fork, which affects the true height, or a major scar at breast height which affects the true diameter.

Do not select trees with:

- diameters that were estimated;
- sweeps or leans greater than 5 degrees.

In some areas, it may be impossible to meet sample height requirements if only suitable trees as described above are taken. In this situation, take the best of the "poor" trees to meet the requirements. However, do not select a tree if its height is less than 95% of what it would be without its defect – lean, fork, broken top, etc.

Measuring Suppressed Trees with Flattened Tops

To ensure accurate measurements of suppressed trees:

1. Sight on the highest point of the top.
2. For hemlock trees, sight on the highest point of the droop.

3. For cedar trees, make sure you take the top reading on the tiny leader and not on a lateral branch, which may be higher.

Age Sample Trees

Note: If the present top height and site trees had their ages taken at 1.3 m during the last measurement, no further ages are required. If the top height tree or any site tree of the first and second leading major species do not have an age at 1.3 m, it must be taken now.

In **single layer, simple stands,** pure and mixed, the age of the stand is determined by averaging the ages of the trees of the leading major species in the sample. However, ages of the site trees of the second major species must also be taken.

The sample mean age is derived from the site trees of the leading species only, even if some of their cores are rotten. The rotten portion must be estimated to derive a total age for the tree. See "Counting Rings on Rotted Cores" in this chapter.

Bore trees that appear to be veterans to confirm they are in fact veterans. Bore the smallest diameter veteran per species only; the others can be assumed to be veterans too. Use these ages for the veteran layer.

In **single layer, complex stands**, the average age of the stand is determined from the ages of the site trees of the leading major species. However, to show the variation of the stand's age, take two additional ages of the leading major species from the younger portion of the stand. Treat the second major species the same as the leading.

In **multi-layer stands**, select sample trees, as outlined above, for each layer.

Taking the Age of a Tree

1. Bore the selected trees at 1.3 m.
2. Remove the core. Make sure two cores per species include the pith.
3. If the core includes the pith, record "Y" in the pith field.
4. Rebore the tree if you missed the pith by more than an estimated:
    - years on a tree younger than 100 years, or
    - percent on a tree older than 100 years.
5. While in the field, count the rings on the core and record the count.
6. Measure and record the radial increment for the last 5, 10 and 20 years.
7. Measure and record the evidence of suppression, if any. See Appendix 23.
8. Place the cores in plastic straws with the following information:
    - the region number, R#
    - the compartment number, Co#
    - the sample number, T#
    - tree number
    - species
    - counted age

Counting Rings on Rotted Cores

If the sample tree has rotten portions:

1. Count the rings on the sound portion of the core.
2. Estimate the number of years in the rotten portion.
3. Add the number of years in the sound portion to the estimated number of years in the rotten portion.
4. Record the total breast-height age with a (**R**)otted for pith.

Estimating Other Plot Attributes

Estimating Crown Closure

Crown closure is the percentage of ground area covered by the vertically projected crowns of trees.

For each plot, estimate and record the crown closure by layer to the nearest 10 percent.

For the veteran component of the plot, record crown closure to the nearest percent. If the crown closure of the veteran component for the sample is six percent or more, it must be classified as a separate layer.

Determining Elevation

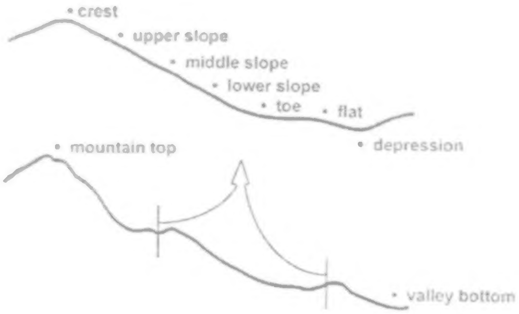
Determine and record the elevation of each plot if not already done.

Determining Aspect and Slope

Determine the aspect and slope for each plot if not already done.

Determining Slope Position

Slope position is the relative position of the plot within a water catchment area. Determine the slope position and record the appropriate code:

Code	Category	Slope Position
C	Crest	
U	Upper	
M	Mid	
L	Lower	
T	Toe	
F	Flat (level)	
D	Depression	

Stem Mapping

If the sample was previously stem mapped, you only have to stem map the tagged ingrowth trees in both the plot and the sub-plot.

Ten percent of the samples established in natural stands are stem mapped. The Terrestrial Information Branch decides which sample and stratum (type group, site, age class) to stem map. The stem maps are used in distance-dependent growth modeling studies.

To create a stem map, you begin from the plot centre stake and measure the bearing and distance to each tagged tree. See Appendix 4 for a list of equipment needed for stem mapping.

To stem map the plot, follow this procedure:

1. If no large tree nearby interferes with sight lines, set up the compass directly over the aluminum plot centre stake, then:
   - level the instrument;
   - record that the compass was not offset.
2. If a large tree interferes with sight lines, set up the compass in an opening close to the plot centre, then:
   - level the instrument;
   - measure and record the bearing and distance from the compass to the plot centre;
   - record that the compass was offset.
3. Adjust the compass for magnetic declination and raise the sighting vanes. In western Canada, magnetic declination is east of true north. Obtain the correct magnetic declination from an isogonic chart. See Appendix 7.
4. Sight on to the first tree on the plot. Some tips for sighting are listed below:
   - to avoid sighting the wrong tree, wrap the dbh stick with flagging tape to make it more visible, then place the stick in front and center of the tree;
   - to avoid false compass readings as you sight the tree, keep sources of magnetic interference away from the compass, including steel tapes, axes, knives, steel datum holders, eye glasses with steel frames, and most metal objects;
   - to simplify recording and possible minimize errors, use a staff compass with Azimuth bearings when possible.
5. Measure the slope distance between the compass and the centre of the tree.
6. Measure the slope with the Suunto clinometer using the percent scale.
7. Read the compass bearing on the scale at the north end of the compass needle.
8. Record the measurements for each tagged tree in the plot.

Quality Control, Damaged Samples and Returning Samples to Victoria

Sampling crews should emphasize accuracy over production. For the standards of measurement, see Appendix 1.

Checking Sampling Crews

To ensure crews follow and understand recommended procedures, carry out regular inspections.

1. Inspect at least 10 percent of all samples remeasured. If the sample has been poorly done, the original crew may be required to redo it.
2. Make spot checks as work progresses to be sure tie points and tie lines are properly marked.
3. To observe sampling crew performance, occasionally visit each crew on the sample.

Checking the Samples in the Office

All samples must be inspected in the office before sending them to the Vegetation Resources Inventory Section of the Terrestrial Information Branch. Ensure that:

1. The sample identification is correct and valid.
2. The sample header is as complete as possible
3. The number and distribution of tree heights - both top height and others - were met.
4. The required number of ages and piths were met.
5. The access notes are complete and include the tie point sketch.

Inspecting the Sample

Once the samples have been checked in the office, randomly select one of the samples and conduct the following:

- a pre-field inspection;
- a field inspection;
- a post-field inspection.

Pre-field Inspection

1. Randomly select one plot from the ones checked in the office.
2. Enter the following information in the section at the top of the plot inspection report:
   - sample identification – region, compartment, sample, sample type, plot
   - the plot and sub-plot sizes;
   - the plot and sub-plot radii;
   - the inspection date;
   - the original tally crew;
   - the measurement date.
3. Randomly select 7 trees from the tree detail section.
4. Transcribe the measurements of the 7 trees to the top section of the plot inspection report, FS 822-1. See Appendix 15.
5. Randomly select five trees for height from the sample tree section.
6. Transcribe the height measurements of the 5 trees to the sample tree section of the plot inspection report.

7. Select two age cores and check the age count as well as the suppression readings.
8. Transcribe the age measurements to the sample tree section of the plot inspection report.
9. Transcribe the crown closure, aspect, slope and slope position of the plot to the appropriate section of the plot inspection report.
10. From the tree count summary section, randomly select one diameter class for a species. Later, you will use this diameter class in the field to check that the dot tally is correct for that class.

Field Inspection

1. Use the access notes to get to the sample and verify their accuracy and completeness.
2. If a new tie tree was selected on remeasurement, check that it was marked as specified in "Checking Location and Access" in this chapter.
3. If a new tie line was run, verify that the bearing and distance were run within the allowable standards.
4. Check that the plot centre markers were inscribed correctly and the plot centre stake was properly protected with a cairn.
5. Check the plot and sub-plot radius at a minimum of three different locations. Look for trees that should have been included or excluded from the plot or sub-plot. Flag with a circled asterisk any tree missed or mistakenly tallied.
6. Check that the chosen diameter class was properly dot tallyed.
7. Carefully measure all the trees you selected in the pre-field inspection:
    - **Tree identification** - Check that the genus or species of each tree inspected is correct. If not, place a circled asterisk beside the tree;
    - **Tree tag height** - Check the tag height of the selected ingrowth trees to verify that breast heights, if applicable, were located at 1.3 m above the germination point for plots established before 1991, or at 1.3 m above the base of the tree on the uphill side for plots established after 1990. At the same time, make sure the nails were securely driven into the trees and the nail with the tag was driven in at a slight angle so that the tag hangs away from the tree;
    - **Diameter and pathological remarks** (decay indicators) - Measure the 7 selected trees and classify them;
    - **Sample tree heights** - Measure the 5 selected trees for height;
    - **Stem mapping** - If the sample was stem mapped, check the selected ingrowth trees for bearing, distance and percent slope.
8. Assess the crown closure for the plot.
9. Compare your measurements with the previous ones giving the crew the benefit of the doubt.
10. Check that the results conform to the standards of measurements. See Appendix 1.
11. If the difference between two measurements is greater than the allowable error, place an asterisk in the margin.
12. If the error is greater than two times the allowable error, circle the asterisk.
13. Complete the inspection items section of the inspection report.

14. Rate the quality of the work on the plot using the weighted system in Appendix 2.
15. Record your rating of the plot and any other comments in the remarks section of the plot inspection report.

Post-field Inspection

1. Discuss the results of your inspection with the original field crew.
2. Make recommendations to the original field crew, if necessary, on how to improve their work.
3. Correct the original data changing all the data that was flagged with an asterisk or a circled asterisk in your inspection report.

Damage to the Sample

Damage to samples can result from natural or artificial causes.

1. If the sample was damaged by natural causes such as slides, snow, fungi, insects, disease and fire, it should be remeasured if at least 25% of the plot trees are still living.
2. If the sample was damaged (disturbed) by artificial means, refer to "Guidelines For Deciding if Damaged Permanent Plots Should be Remeasured" in Appendix 20.

If a sample is to be destroyed:

1. Remeasure it one last time if at least three years have elapsed since the last measurement.
2. Classify it ecologically.
3. Make sure the plot centre can be relocated after logging so that the long-term productivity effects can be determined.

Returning the Samples to Victoria

Once the samples are checked in the office and corrected:

1. Send a list of all the samples, any original field sheets, the electronic download from the GyHost as well as a hard copy of reports 1,2,3,5,6 and 7 to the Vegetation Resources Inventory Section of the Terrestrial Information Branch.
2. Keep a copy of all the above in the forest region for security and reference.

Appendix 1: Standards of Measurement for Permanent Samples

Tie Line

Bearing	±2°
Distance	±2%

Plot

Missed and extra trees	No error within the plot.
Radius	± 0.5% of plot/sub-plot radius tolerance for borderline trees.
Tree species	No error, but identication to genus level allowable for birch, interior spruce and willow.
Breast height	±5 cm
D.B.H. live	±0.1 cm or 1.0%, whichever is greater.
D.B.H. dead	±0.2 cm or 2.0% whichever is greater.
Decay indicators	±1 or 10%, whichever is greater, of the total number of external indicators of all trees checked.
Crown closure	± one 10% class
Live crown	± one 10% class
Crown class	± one crown class
Quality	± 1 or 10%, whichever is greater, of the total number of trees checked.
Measured tree height	± 20 cm or 2%, whichever is greater.
Estimated tree height	+or- 0.5m or 10%, whichever is greater.
Tree age	±2 years or 2%, whichever is greater.
Radial increment	±0.1 cm
Slope	± 5%,
Aspect	± 10 degrees
Elevation	± 50 metres
Wildlife Visual Appearance	± 1 visual appearance class

Stem Mapping

Bearing	±2°
Distance	±2%

Location

Latitude	± 1 second
Longitude	± 1 second
UTM	± 20 metres

Appendix 2: Weighted Error Rating Table and the Basis for the Acceptance or Rejection of a Plot

Symbol		Weighted error
⊛	Missed and/or extra plot trees	2
⊛	Missed and/or extra sub-plot trees (less than 2.0 cm d.b.h.)	½
⊛	Missed and/or extra dead trees	½
⊛	Missed an/or extra sub-plot trees (greater than or equal to 2.0 cm d.b.h.	1
⊛	Tree genus/species	2
⊛	Breast height	1
⊛	D.B.H. Live tree	2
	D.B.H. dead tree	½
⊛	Path	1
⊛	Live Crown	½
⊛	Crown Class	½
⊛	Quality	½
⊛	Dead tree wildlife visual appearance	½
⊛	Radial increment	½
⊛	Crown closure	½
⊛	Measured height	2
⊛	Estimated height	½
⊛	Total age	1
⊛	Bearing	1
⊛	Distance	1
⊛	Slope	½
⊛	Aspect	½
⊛	Elevation	½
*	Asterisk	50% of above

Note: If the weighted errors result in a plot rating greater than four, redo the sample or portions of it.

Appendix 3: Species Symbols [1]

Names and Symbols for Tree Species in B.C.

Common Name of Genus/Species	Scientific Name	Genus Symbol	Species Symbol	C/N**	S/G***
Alder	**Alnus**	D			
Red alder	A. rubra		Dr	C	S
Apple	**Malus**	U			
Apple	Malus pumila		Ua	N	S
Pacific crab apple	Malus fusca		Up	N	S
Arbutus	**Arbutus**	R			
Arbutus	A. menziesii		Ra	N	S
Aspen, Cottonwood or Poplar	**Populus**	A			
Poplar	P. balsamifera		Ac	C	S
Balsam poplar	P. b. ssp.balsamifera		Acb	C	S
Black cottonwood	P. b. ssp. trichocarpa		Act	C	S
Hybrid poplars	P. spp.		Ax	C	S
*Southern cottonwood	P. deltoids		Ad	C	S
Trembling aspen	P. tremuloides		At	C	S
Balsam	**Abies**	B			
Amabilis fir	A. amabilis		Ba	C	S
Subalpine fir	A. lasiocarpa		Bl	C	S
*Balsam fir	A. balsamea		Bb	C	S
Grand fir	A. grandis		Bg	C	S
Noble fir	A. procera		Bp	C	S
*Shasta red fir	A. magnifica var. shastensis		Bm	C	S
*White fir	A. concolor		Bc	C	S
Birch	**Betula**	E			
Alaska paper birch	B. neoalaskana		Ea	C	S
Alaska x paper birch hybrid	B. x winteri		Exp	C	G
European birch	B. pendula		Ee	C	G
Paper birch	B. papyrifera		Ep	C	S
Silver birch	B. pubescens		Es	C	G
Water birch	B. occidentalis		Ew	N	S
*Yellow birch	B. alleghaniensis		Ey	C	S

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[1] Based on 'The BC Tree Code List' Version 4.3

* Introduced Species

** C - commercial tree; N - non commercial tree

*** S - Code to species level; G - May be coded to genus level

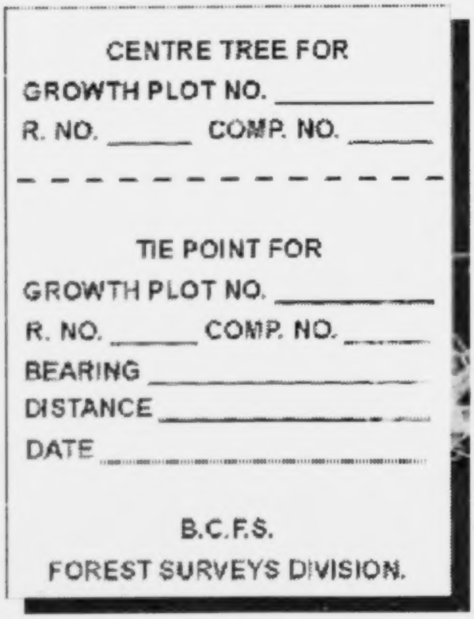
Common Name of Genus/Species	Scientific Name	Genus Symbol	Species Symbol	C/N**	S/G***
Cascara	**Rhamnus**	K			
Cascara	R. purshianus		Kc	N	S
Cedar	**Thuja**	C			
Western red cedar	T. plicata		Cw	C	S
Cherry	**Prunus**	V			
Bitter cherry	P. emarginata		Vb	N	S
Choke cherry	P. virginiana		Vv	N	S
Pin cherry	P. pennsylvanica		Vp	N	S
Sweet cherry	P. avium		Vs	N	S
Cypress	**Chamaecyparis**	Y			
*Port Orford-cedar	C. lawsoniana		Yp	C	S
Yellow cedar	C. nootkatensis		Yc	C	S
Dogwood	**Cornus**	G			
Pacific dogwood	C. nuttallii		Gp	N	S
Douglas-fir	**Pseudotsuga**	F			
Douglas-fir	P. menziesii		Fd	C	S
Coastal Douglas-fir	P. menziesii var. menziesii		Fdc	C	S
Interior Douglas-fir	P. menziesii var. glauca		Fdi	C	S
Hemlock	**Tsuga**	H			
Mountain hemlock	T. mertensiana		Hm	C	S
Mountain x western hemlock hybrid	T. mertensiana x heterophylla		Hxm	C	S
Western hemlock	T. heterophylla		Hw	C	S
Juniper	**Juniperus**	J			
Rocky mountain juniper	J. scopulorum		Jr	N	S
Larch	**Larix**	L			
Alpine larch	L. lyallii		La	C	S
*Dahurian Larch	L. gmelinii		Ld	N	S
Tamarack	L. laricina		Lt	C	S
Western larch	L. occidentalis		Lw	C	S
Maple	**Acer**	M			
Bigleaf maple	A. macrophyllum		Mb	C	S
Box elder	A. negundo		Me	C	S
*Norway maple	A. platanoides		Mn	C	S
*Sycamore maple	A. pseudoplatanaus		Ms	C	S
Vine maple	A. circinatum		Mv	N	S
Oak	**Quercus**	Q			
*English oak	Q. robur		Qe	C	S
Garry oak	Q. garryana		Qg	N	S
*White Oak	Q. alba		Qw	C	S
Other exotics					
*Coast redwood	Sequoia sempervirens		Oc	C	S
Common pear	Pyrus communis		Of	N	S
European mountain-ash	Sorbus aucuparia		Od	N	S
*Giant sequoia	Sequoiadendron giganteum		Ob	C	S

Common Name of Genus/Species	Scientific Name	Genus Symbol	Species Symbol	C/N**	S/G***
*Incense-cedar	Calocedrus decurrens		Oa	C	S
Oregon ash	Fraxinus latifolia		Og	C	S
*White Ash	Fraxinus americana		Oh	C	S
*Shagbark hickory	Carya ovata		Oi	C	S
Siberian elm	Ulmus pumila		Oe	N	S
Pine	**Pinus**	P			
Jack pine	P. banksiana		Pj	C	S
Limber pine	P. flexilis		Pf	C	S
Lodgepole pine	P. contorta		Pl	C	S
Lodgepole pine	P. contorta var. latifolia		Pli	C	S
Lodgepole x jack pine hybrid	P. x murraybanksiana		Pxj	C	S
*Monterey pine	P. radiata		Pm	C	S
Ponderosa pine	P. ponderosa		Py	C	S
*Red pine	P. resinosa		Pr	C	S
Shore pine	P. contorta var. contorta		Plc	C	S
*Sugar pine	P. lambertiana		Ps	C	S
Western white pine	P. monticola		Pw	C	S
Whitebark pine	P. albicaulis		Pa	C	S
Spruce	**Picea**	S			
Black spruce	P. mariana		Sb	C	S
Engelmann spruce	P. engelmannii		Se	C	G
*Norway spruce	P. abies		Sn	C	G
Sitka spruce	P. sitchensis		Ss	C	S
White spruce	P. glauca		Sw	C	G
Spruce hybrid	Picea cross		Sx	C	G
Engelmann x white	P. engelmannii x glauca		Sxw	C	G
Sitka x white	P. x lutzii		Sxl	C	G
Sitka x unknown hybrid	P. sitchensis x ?		Sxs	C	G
Willow	**Salix**	W			
Bebb's willow	S. bebbiana		Wb	N	G
Pacific willow	S. lucida		Wp	N	G
Peachleaf willow	S. amygdaloides		Wa	N	G
Pussy willow	S. discolor		Wd	N	G
Scouler's willow	S. scouleriana		Ws	N	G
Sitka willow	S. sitchensis		Wt	N	G
Yew	**Taxus**	T			
Western yew	Taxus brevifolia		Tw	N	S
Unknown Conifer		X	Xc		S
Unknown Hardwood			Xh		S
Other Conifer		Z	Zc		S
Other Hardwood			Zh		S

Appendix 4: Equipment List for Permanent Sample Measurements

1. Personal tally gear (Silva compass, d.b.h. tape, Suunto)
2. Safety gear (hard hat, first aid kit, flare kit)
3. Pertinent section of the manual
4. Electronic field recorder
5. Pertinent field sheets
6. Pertinent plot radii slope allowance table
7. 50 m tape
8. GY annotated flagging tape
9. Blue tree paint
10. Aluminum centre stakes (90 cm)
11. Aluminum plot markers
12. Aluminum nails (6 cm)
13. Blue plastic tree tags (with embossed white numbers)
14. Blank aluminum tree tags
15. Claw hammer
16. Increment borer, hand lens
17. Plot string

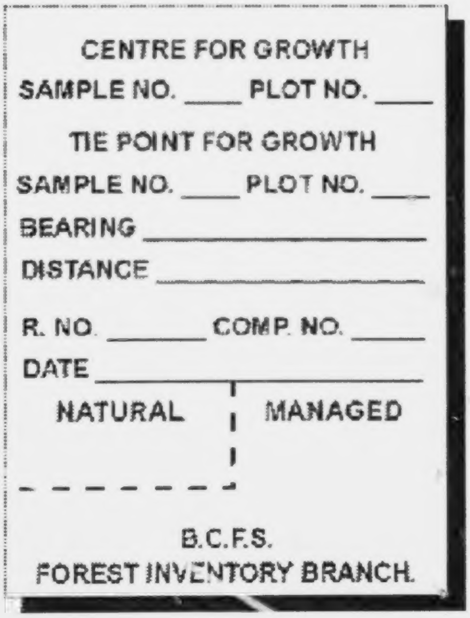
Appendix 5: Tie Point and Plot Centre Aluminum Markers



CENTRE TREE FOR
GROWTH PLOT NO. ____________
R. NO. ______ COMP. NO. ______

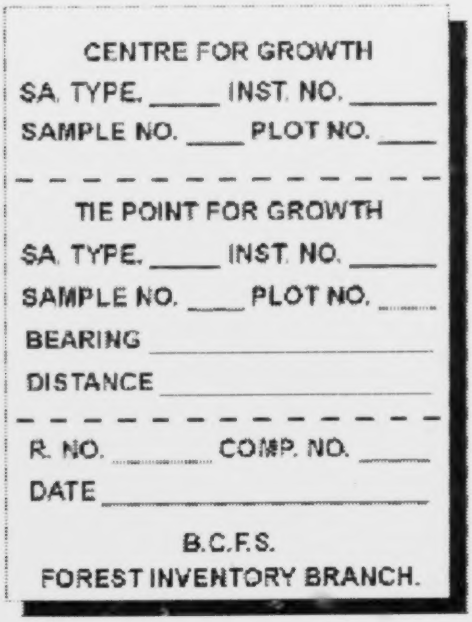
TIE POINT FOR
GROWTH PLOT NO. ____________
R. NO. ______ COMP. NO. ______
BEARING ________________
DISTANCE ________________
DATE ________________

B.C.F.S.
FOREST SURVEYS DIVISION.



CENTRE FOR GROWTH
SAMPLE NO. ____ PLOT NO. ____
TIE POINT FOR GROWTH
SAMPLE NO. ____ PLOT NO. ____
BEARING ________________
DISTANCE ________________
R. NO. ______ COMP. NO. ______
DATE ________________
NATURAL | MANAGED

B.C.F.S.
FOREST INVENTORY BRANCH.



CENTRE FOR GROWTH
SA. TYPE. _____ INST. NO. ______
SAMPLE NO. ____ PLOT NO. ____

TIE POINT FOR GROWTH
SA. TYPE. _____ INST. NO. ______
SAMPLE NO. ____ PLOT NO. ____
BEARING ________________
DISTANCE ________________

R. NO. ______ COMP. NO. ______
DATE ________________

B.C.F.S.
FOREST INVENTORY BRANCH.

Appendix 6: Plot and Sub-plot Radii Slope Allowance for Natural Stands Samples

	Plot Size (ha)/P.H.F. Plot Radii (m)			Plot and Sub-plot Size (ha), P.H.F., and Radii (m)													
	0.102	0.081	0.0503	.1	0.09	0.08	0.07	0.06	0.05	0.04	0.03	0.025	0.02	0.015	0.01	0.007	0.005
	9.88	12.36	19.76	10.0	11.11	12.50	14.29	16.67	20.00	25.00	33.33	40.00	50.00	66.67	100.00	142.86	200.00
	17.98	16.06	12.65	17.84	16.93	15.96	14.93	13.82	12.62	11.28	9.77	8.92	7.98	6.91	5.64	4.72	3.99
Slope %	**Plot Radii Plus Slope Allowance (m)**			**Sub-plot Radii Plus Slope Allowance (m)**													
10	18.07	16.14	12.71	17.93	17.01	16.04	15.00	13.89	12.68	11.34	9.82	8.96	8.02	6.94	5.67	4.74	4.01
12	18.11	16.18	12.74	17.97	17.05	16.07	15.04	13.92	12.71	11.36	9.84	8.98	8.04	6.96	5.68	4.75	4.02
14	18.16	16.22	12.77	18.01	17.10	16.12	15.08	13.95	12.74	11.39	9.87	9.01	8.06	6.98	5.70	4.77	4.03
16	18.21	16.26	12.81	18.07	17.15	16.16	15.12	14.00	12.78	11.42	9.89	9.03	8.08	7.00	5.71	4.78	4.04
18	18.27	16.32	12.85	18.13	17.20	16.22	15.17	14.04	12.82	11.46	9.93	9.06	8.11	7.02	5.73	4.80	4.05
20	18.34	16.38	12.90	18.19	17.27	16.28	15.23	14.09	12.87	11.50	9.96	9.10	8.14	7.05	5.75	4.81	4.07
22	18.41	16.44	12.95	18.27	17.33	16.34	15.29	14.15	12.92	11.55	10.00	9.13	8.17	7.08	5.77	4.83	4.09
24	18.49	16.52	13.01	18.35	17.41	16.41	15.35	14.21	12.98	11.60	10.05	9.17	8.21	7.11	5.80	4.85	4.10
26	18.58	16.59	13.07	18.43	17.49	16.49	15.43	14.28	13.04	11.66	10.09	9.22	8.25	7.14	5.83	4.88	4.12
28	18.67	16.68	13.14	18.53	17.58	16.57	15.50	14.35	13.11	11.71	10.15	9.26	8.29	7.18	5.86	4.90	4.14
30	18.77	16.77	13.21	18.63	17.68	16.66	15.59	14.43	13.18	11.78	10.20	9.31	8.33	7.21	5.89	4.93	4.17
32	18.88	16.86	13.28	18.73	17.78	16.76	15.68	14.51	13.25	11.84	10.26	9.37	8.38	7.26	5.92	4.96	4.19
34	18.99	16.96	13.36	18.84	17.88	16.86	15.77	14.60	13.33	11.91	10.32	9.42	8.43	7.30	5.96	4.99	4.21
36	19.11	17.07	13.44	18.96	17.99	16.96	15.87	14.69	13.41	11.99	10.38	9.48	8.48	7.34	5.99	5.02	4.24
38	19.23	17.18	13.53	19.08	18.11	17.07	15.97	14.78	13.50	12.07	10.45	9.54	8.54	7.39	6.03	5.05	4.27
40	19.37	17.30	13.62	19.21	18.23	17.19	16.08	14.88	13.59	12.15	10.52	9.61	8.59	7.44	6.07	5.08	4.30
42	19.50	17.42	13.72	19.35	18.36	17.31	16.19	14.99	13.69	12.23	10.60	9.67	8.66	7.49	6.12	5.12	4.33
44	19.64	17.55	13.82	19.49	18.50	17.44	16.31	15.10	13.79	12.32	10.67	9.75	8.72	7.55	6.16	5.16	4.36
46	19.79	17.68	13.92	19.64	18.64	17.57	16.43	15.21	13.89	12.42	10.75	9.82	8.78	7.61	6.21	5.20	4.39
48	19.94	17.81	14.03	19.79	18.78	17.70	16.56	15.33	14.00	12.51	10.84	9.89	8.85	7.66	6.26	5.24	4.43
50	20.10	17.96	14.14	19.95	18.93	17.84	16.69	15.45	14.11	12.61	10.92	9.97	8.92	7.73	6.31	5.28	4.46
52	20.27	18.10	14.26	20.11	19.08	17.99	16.83	15.58	14.22	12.71	11.01	10.05	8.99	7.79	6.36	5.32	4.50

54	20.43	18.25	14.38	20.27	19.24	18.14	16.97	15.71	14.34	12.82	11.10	10.14	9.07	7.85	6.41	5.36	4.53
56	20.61	18.41	14.50	20.45	19.40	18.29	17.11	15.84	14.46	12.93	11.20	10.22	9.15	7.92	6.46	5.41	4.57
58	20.79	18.57	14.62	20.62	19.57	18.45	17.26	15.98	14.59	13.04	11.29	10.31	9.23	7.99	6.52	5.46	4.61
60	20.97	18.73	14.75	20.80	19.74	18.61	17.41	16.12	14.72	13.15	11.39	10.40	9.31	8.06	6.58	5.50	4.65
62	21.16	18.90	14.88	20.99	19.92	18.78	17.57	16.26	14.85	13.27	11.50	10.50	9.39	8.13	6.64	5.55	4.69
64	21.35	19.07	15.02	21.18	20.10	18.95	17.73	16.41	14.98	13.39	11.60	10.59	9.47	8.20	6.70	5.60	4.74
66	21.54	19.24	15.16	21.38	20.28	19.12	17.89	16.56	15.12	13.52	11.71	10.69	9.56	8.28	6.76	5.66	4.78
68	21.74	19.42	15.30	21.57	20.47	19.30	18.05	16.71	15.28	13.64	11.81	10.79	9.65	8.36	6.82	5.71	4.83
70	21.95	19.60	15.44	21.78	20.67	19.48	18.22	16.87	15.40	13.77	11.93	10.89	9.74	8.43	6.88	5.76	4.87
72	22.16	19.79	15.59	21.98	20.86	19.67	18.40	17.03	15.55	13.90	12.04	10.99	9.83	8.51	6.95	5.82	4.92
74	22.37	19.98	15.74	22.19	21.06	19.85	18.57	17.19	15.70	14.03	12.15	11.10	9.93	8.60	7.02	5.87	4.96
76	22.58	20.17	15.89	22.41	21.26	20.05	18.75	17.36	15.85	14.17	12.27	11.20	10.02	8.68	7.08	5.93	5.01
78	22.80	20.37	16.04	22.63	21.47	20.24	18.93	17.53	16.01	14.31	12.39	11.31	10.12	8.76	7.15	5.99	5.06
80	23.03	20.57	16.20	22.85	21.68	20.44	19.12	17.70	16.16	14.45	12.51	11.42	10.22	8.85	7.22	6.04	5.11
82	23.25	20.77	16.36	23.07	21.89	20.64	19.31	17.87	16.32	14.59	12.63	11.54	10.32	8.94	7.29	6.10	5.16
84	23.48	20.97	16.52	23.20	22.11	20.84	19.50	18.05	16.48	14.73	12.76	11.65	10.42	9.02	7.37	6.16	5.21
86	23.71	21.18	16.68	23.53	22.33	21.05	19.69	18.23	16.65	14.88	12.89	11.76	10.53	9.11	7.44	6.23	5.26
88	23.95	21.39	16.85	23.76	22.55	21.26	19.89	18.41	16.81	15.03	13.01	11.88	10.63	9.20	7.51	6.29	5.31
90	24.19	21.61	17.02	24.00	22.78	21.47	20.09	18.59	16.98	15.18	13.14	12.00	10.74	9.30	7.59	6.35	5.37
92	24.43	21.82	17.19	24.24	23.00	21.69	20.29	18.78	17.15	15.33	13.28	12.12	10.84	9.39	7.66	6.41	5.42
94	24.68	22.04	17.36	24.48	23.24	21.90	20.49	18.97	17.32	15.48	13.41	12.24	10.95	9.48	7.74	6.48	5.48
96	24.92	22.26	17.54	24.73	23.47	22.12	20.70	19.16	17.49	15.64	13.54	12.37	11.06	9.58	7.82	6.54	5.53
98	25.17	22.49	17.71	24.98	23.70	22.35	20.90	19.35	17.67	15.79	13.68	12.49	11.17	9.67	7.90	6.61	5.59
100	25.43	22.71	17.89	25.23	23.94	22.57	21.11	19.54	17.85	15.95	13.82	12.61	11.29	9.77	7.98	6.68	5.64

	The sub-plot sizes can be measured by holding the tape horizontally:					
plot (ha)	0.004	0.003	0.002	0.001	0.0005	0.0003
P.H.F.	250.00	333.33	500.00	1000.00	2000.00	3333.33
Plot Radii (m)	3.57	3.09	2.52	1.78	1.26	0.98

P.H.F. is the Per Hectare Factor.

Appendix 7: Isogonic and Isoporic Table

Magnetic Declination and Annual Change for May 2002

Latitude and Longitude for selected points for Magnetic Declination determination and Annual Change					
Region	Location	Latitude	Longitude	Declination May 2002	Annual Change
		in degrees, minutes			
Cariboo	Quesnel townsite	52,57	122,30	20 41 E	11.5 W
Cariboo	Farwell Canyon	51,49	122,34	20 10 E	10.6 W
Cariboo	mid - Horsefly Lake	52,24	121,02	20 07 E	11.0 W
Cariboo	100 Mile House Townsite	51,39	121,17	19 49 E	10.5 W
Cariboo	Chilanko Forks Settlement	52,07	124,04	20 35 E	10.9 W
Kamloops	Chase	50,49	119,41	19 05 E	9.8 W
Kamloops	Lillooet	50,40	121,56	19 31 E	9.8 W
Kamloops	Merritt	50,07	120,47	19 02 E	9.4 W
Kamloops	Princeton	49,28	120,30	18 42 E	8.9 W
Kamloops	Penticton	49,30	119,35	18 30 E	8.9 W
Kamloops	Vernon	50,16	119,16	18 44 E	9.4 W
Kamloops	Salmon Arm	50,42	119,16	18 56 E	9.7 W
Kamloops	Kamloops	50,40	120,19	19 10 E	9.7 W
Kamloops	Clearwater	51,39	120,02	19 32 E	10.4 W
Nelson	Beaverdell	49,26	119,05	18 21 E	8.8 W
Nelson	Castlegar	49,19	117,39	17 55 E	8.7 W
Nelson	Cranbrook	49,30	115,46	17 23 E	8.8 W
Nelson	Creston	49,06	116,31	17 29 E	8.5 W
Nelson	Flathead	49,22	114,37	16 53 E	8.6 W
Nelson	Golden	51,18	116,58	18 31 E	10.1 W
Nelson	Grand Forks	49,02	118,27	18 02 E	8.6 W
Nelson	Invermere	50,31	116,02	17 52 E	9.5 W
Nelson	Kalso	49,55	116,54	17 56 E	9.1 W
Nelson	Mica Creek	52,05	118,34	19 21 E	10.7 W
Nelson	Nakusp	50,14	117,48	18 20 E	9.3 W
Nelson	Nelson	49,29	117,17	17 52 E	8.8 W
Nelson	Revelstoke	50,59	118,12	18 46 E	9.9 W
Nelson	Sparwood	49,43	114,53	17 07 E	8.9 W
Prince George	Valemount	52,50	119,15	19 53 E	11.3 W
Prince George	McBride	53,18	120,10	20 20E	11.7 W
Prince George	Hixon	53,52	122,35	21 09 E	12.3 W
Prince George	Prince George	53,55	122,45	21 13 E	12.3 W
Prince George	Bear Lake (Hart Hwy)	54,30	122,40	21 30 E	12.8 W
Prince George	Vanderhoof	54,01	124,01	21 30 E	12.4 W
Prince George	Kenny Dam	53,36	124,58	21 27 E	12.0 W
Prince George	Ft. St. James	54,26	124,15	21 46 E	12.8 W
Prince George	Takla Landing	55,29	125,58	22 38 E	13.7 W
Prince George	Manson Creek	55,40	124,29	22 31 E	13.9 W
Prince George	Aiken Lake	56,26	125,45	23 11 E	14.6 W
Prince George	Bear Lake (Driftwood)	56,12	126,51	23 10 E	14.3 W
Prince George	Mackenzie	55,18	123,10	22 03 E	13.5 W
Prince George	Fort Ware	57,26	125,38	23 50 E	15.6 W
Prince George	Ingenika Point	56,47	124,52	23 17 E	15.0 W
Prince George	Ingenika Mine	56,42	125,11	23 17 E	14.9 W
Prince George	Dawson Creek	55,46	120,14	21 36 E	14.0 W
Prince George	Chetwynd	55,42	121,38	21 56 E	13.9 W
Prince George	Tumbler Ridge	55,07	120,55	21 26 E	13.4 W

Latitude and Longitude for selected points for Magnetic Declination determination and Annual Change

Region	Location	Latitude	Longitude	Declination May 2002	Annual Change
		in degrees, minutes			
Prince George	Fort St. John	56,15	120,51	22 03 E	14.5 W
Prince George	Beaton River (settl.)	57,23	121,25	22 56 E	15.7 W
Prince George	Pink Mountain	57,02	122,31	22 59 E	15.3 W
Prince George	Fort Nelson	58,48	122,43	24 17 E	17.4 W
Prince George	Muncho Lake	58,59	125,47	24 56 E	17.4 W
Prince George	Nelson Forks	59,30	124,01	25 05 E	18.2 W
Prince Rupert	Burns Lake	54,21	126,31	22 04 E	12.6 W
Prince Rupert	Houston	54,27	126,37	22 08 E	12.7 W
Prince Rupert	Smithers	54,47	127,11	22 23 E	13.0 W
Prince Rupert	Hazelton	55,13	127,35	22 40 E	13.4 W
Prince Rupert	Terrace	54,31	128,36	22 23 E	12.7 W
Prince Rupert	Prince Rupert	54,18	130,20	22 23 E	12.5 W
Prince Rupert	Stewart	55,57	130,00	23 13 E	13.9 W
Prince Rupert	Lower Post	55,55	128,32	23 09 E	13.9 W
Prince Rupert	Dease Lake	58,27	130,02	24 40 E	16.3 W
Prince Rupert	Atlin	59,35	133,41	25 00 E	16.8 W
Vancouver	Chilliwack	49,10	121,57	18 55 E	8.7 W
Vancouver	Haney	49,13	122,36	19 05 E	8.8 W
Vancouver	Abbotsford	49,03	122,17	18 57 E	8.6 W
Vancouver	Vancouver	49,15	123,07	19 12 E	8.8 W
Vancouver	Squamish	49,45	123,07	19 24 E	9.1 W
Vancouver	Powell River	49,51	124,32	19 43 E	9.2 W
Vancouver	Campbell River	50,01	125,20	19 56 E	9.3 W
Vancouver	Port McNeill	50,35	127,06	20 26 E	9.7 W
Vancouver	Gold River	49,41	126,07	19 56 E	9.1 W
Vancouver	Nanaimo	49,10	123,56	19 21 E	8.7 W
Vancouver	Tofino	49,07	125,53	19.41 E	8.8 W
Vancouver	Duncan	48,47	123,42	19 09 E	8.5 W
Vancouver	Port Alberni	49,14	124,58	19 34 E	8.8 W
Vancouver	Sayward	50,23	125,58	20 11 E	9.6 W
Vancouver	Holberg	50,39	128,01	20 34 E	9.8 W
Vancouver	Port Renfrew	48,33	124,25	19 13 E	8.4 W
Vancouver	Massett	54,01	132,06	22 16 E	12.2 W
Vancouver	Queen Charlotte City	53,15	128,31	21 45 E	11.7 W
Vancouver	Klemtu	52,35	128,31	21 27 E	11.2 W
Vancouver	Hagensborg	52,23	126,33	21 07 E	11.1 W
Vancouver	Security Bay	51,22	127,28	20 48 E	10.3 W
Vancouver	Alison Sound	51,15	127,00	20 42 E	10.2 W
Vancouver	Pemberton	50,19	122,48	19 34 E	9.5 W
Vancouver	Boston Bar	49,52	121,26	19 05 E	9.2 W
Vancouver	Stuart Island	50,22	125,08	20 02 E	9.6 W
Vancouver	Sewell Inlet	52,53	131,59	21 44 E	11.4 W
Vancouver	Franklin River	49,00	124,45	19 26 E	8.7 W
Vancouver	Rivers Inlet	51,41	127,15	20 55 E	10.5 W

If you require a declination for a location not listed above, the following Internet site will give it to you provided that you know the latitude and longitude in degrees and minutes.

http://www.geolab.nrcan.gc.ca/geomag/e_cgrf.html

Appendix 8: Plot and Sub-Plot Radii Slope Allowance For Treated Stands

	Plot and Sub-plot Size (ha)/P.H.P./Radii (m)																				
	0.30	0.225	0.19	0.15	0.12	0.1	0.09	0.08	0.07	0.06	0.05	0.04	0.032	0.03	0.025	0.024	0.02	0.016	0.015	0.012	0.01
	3.33	4.44	5.26	6.67	8.33	10.0	11.11	12.50	14.29	16.67	20.00	25.00	31.25	33.33	40.00	41.67	50.00	62.50	66.67	83.33	100.0
	30.90	26.76	24.59	21.85	19.54	17.84	16.93	15.96	14.93	13.82	12.62	11.28	10.09	9.77	8.92	8.74	7.98	7.14	6.91	6.18	5.64
Slope %	Plot and Sub-plot Radii Plots Slope Allowance (m)																				
10	31.05	26.89	24.71	21.96	19.64	17.93	17.01	16.04	15.00	13.89	12.68	11.34	10.14	9.82	8.96	8.78	8.02	7.18	6.94	6.21	5.67
12	31.12	26.95	24.77	22.01	19.68	17.97	17.05	16.07	15.04	13.92	12.71	11.36	10.16	9.84	8.98	8.80	8.04	7.19	6.96	6.22	5.68
14	31.20	27.02	24.83	22.06	19.73	18.01	17.10	16.12	15.08	13.95	12.74	11.39	10.19	9.87	9.01	8.83	8.06	7.21	6.98	6.24	5.70
16	31.29	27.10	24.90	22.13	19.79	18.07	17.15	16.16	15.12	14.00	12.78	11.42	10.22	9.89	9.03	8.85	8.08	7.23	7.00	6.26	5.71
18	31.40	27.19	24.99	22.20	19.85	18.13	17.20	16.22	15.17	14.04	12.82	11.46	10.25	9.93	9.06	8.88	8.11	7.25	7.02	6.28	5.73
20	31.51	27.29	25.08	22.28	19.93	18.19	17.27	16.28	15.23	14.09	12.87	11.50	10.29	9.96	9.10	8.91	8.14	7.28	7.05	6.30	5.75
22	31.64	27.40	25.18	22.37	20.01	18.27	17.33	16.34	15.29	14.15	12.92	11.55	10.33	10.00	9.13	8.95	8.17	7.31	7.08	6.33	5.77
24	31.78	27.52	25.29	22.47	20.09	18.35	17.41	16.41	15.35	14.21	12.98	11.60	10.38	10.05	9.17	8.99	8.21	7.34	7.11	6.36	5.80
26	31.93	27.65	25.41	22.58	20.19	18.43	17.49	16.49	15.43	14.28	13.04	11.66	10.43	10.09	9.22	9.03	8.25	7.38	7.14	6.39	5.83
28	32.09	27.79	25.54	22.69	20.29	18.53	17.58	16.57	15.50	14.35	13.11	11.71	10.48	10.15	9.26	9.08	8.29	7.41	7.18	6.42	5.86
30	32.26	27.94	25.67	22.81	20.40	18.63	17.68	16.66	15.59	14.43	13.18	11.78	10.53	10.20	9.31	9.12	8.33	7.45	7.21	6.45	5.89
32	32.44	28.10	25.82	22.94	20.52	18.73	17.78	16.76	15.68	14.51	13.25	11.84	10.59	10.26	9.37	9.18	8.38	7.50	7.26	6.49	5.92
34	32.64	28.26	25.97	23.08	20.64	18.84	17.88	16.86	15.77	14.60	13.33	11.91	10.66	10.32	9.42	9.23	8.43	7.54	7.30	6.53	5.96
36	32.84	28.44	26.13	23.22	20.77	18.96	17.99	16.96	15.87	14.69	13.41	11.99	10.72	10.38	9.48	9.29	8.48	7.59	7.34	6.57	5.99
38	33.06	28.63	26.31	23.37	20.90	19.08	18.11	17.07	15.97	14.78	13.50	12.07	10.79	10.45	9.54	9.35	8.54	7.64	7.39	6.61	6.03
40	33.28	28.82	26.48	23.53	21.05	19.21	18.23	17.19	16.08	14.88	13.59	12.15	10.87	10.52	9.61	9.41	8.59	7.69	7.44	6.66	6.07
42	33.51	29.02	26.67	23.70	21.19	19.35	18.36	17.31	16.19	14.99	13.69	12.23	10.94	10.60	9.67	9.48	8.66	7.74	7.49	6.70	6.12
44	33.76	29.24	26.87	23.87	21.35	19.49	18.50	17.44	16.31	15.10	13.79	12.32	11.02	10.67	9.75	9.55	8.72	7.80	7.55	6.75	6.16
46	34.01	29.46	27.07	24.05	21.51	19.64	18.64	17.57	16.43	15.21	13.89	12.42	11.11	10.75	9.82	9.62	8.78	7.86	7.61	6.80	6.21
48	34.28	29.68	27.28	24.24	21.67	19.79	18.78	17.70	16.56	15.33	14.00	12.51	11.19	10.84	9.89	9.69	8.85	7.92	7.66	6.86	6.26
50	34.55	29.92	27.49	24.43	21.85	19.95	18.93	17.84	16.69	15.45	14.11	12.61	11.28	10.92	9.97	9.77	8.92	7.98	7.73	6.91	6.31
52	34.83	30.16	27.72	24.63	22.02	20.11	19.08	17.99	16.83	15.58	14.22	12.71	11.37	11.01	10.05	9.85	8.99	8.05	7.79	6.97	6.36
54	35.12	30.41	27.95	24.83	22.21	20.27	19.24	18.14	16.97	15.71	14.34	12.82	11.47	11.10	10.14	9.93	9.07	8.11	7.85	7.02	6.41
56	35.42	30.67	28.18	25.04	22.40	20.45	19.40	18.29	17.11	15.84	14.46	12.93	11.56	11.20	10.22	10.02	9.15	8.18	7.92	7.08	6.46
58	35.72	30.94	28.43	25.26	22.59	20.62	19.57	18.45	17.26	15.98	14.59	13.04	11.66	11.29	10.31	10.10	9.23	8.25	7.99	7.14	6.52
60	36.04	31.21	28.68	25.48	22.79	20.80	19.74	18.61	17.41	16.12	14.72	13.15	11.77	11.39	10.40	10.19	9.31	8.33	8.06	7.21	6.58
62	36.36	31.49	28.93	25.71	22.99	20.99	19.92	18.78	17.57	16.26	14.85	13.27	11.87	11.50	10.50	10.28	9.39	8.40	8.13	7.27	6.64
64	36.69	31.77	29.19	25.94	23.20	21.18	20.10	18.95	17.73	16.41	14.98	13.39	11.98	11.60	10.59	10.38	9.47	8.48	8.20	7.34	6.70
66	37.02	21.06	29.46	26.18	23.41	21.38	20.28	19.12	17.89	16.56	15.12	13.52	12.09	11.71	10.69	10.47	9.56	8.55	8.28	7.40	6.76
68	37.37	32.36	29.74	16.42	23.63	21.57	20.47	19.30	18.05	16.71	15.26	13.64	12.20	11.81	10.79	10.57	9.65	8.63	8.36	7.47	6.82
70	37.72	32.66	30.02	26.67	23.85	21.78	20.67	19.48	18.22	16.87	15.40	13.77	12.32	11.93	10.89	10.67	9.74	8.72	8.43	7.54	6.88
72	38.08	32.97	30.30	26.92	24.08	21.98	20.86	19.67	18.40	17.03	15.55	13.90	12.43	12.04	10.99	10.77	9.83	8.80	8.51	7.62	6.95
74	38.44	33.29	30.59	27.18	24.31	22.19	21.06	19.85	18.57	17.19	15.70	14.03	12.55	12.15	11.10	10.87	9.93	8.88	8.60	7.69	7.02
76	38.81	33.61	30.89	27.44	24.54	22.41	21.26	20.05	18.75	17.36	15.85	14.17	12.67	12.27	11.20	10.98	10.02	8.97	8.68	7.76	7.08
78	39.19	33.94	31.19	27.71	24.78	22.63	21.47	20.24	18.93	17.53	16.01	14.31	12.80	12.39	11.31	11.08	10.12	9.06	8.76	7.84	7.15
80	39.57	34.27	31.49	27.98	25.02	22.85	21.68	20.44	19.12	17.70	16.16	14.45	12.92	12.51	11.42	11.19	10.22	9.14	8.85	7.91	7.22
82	39.96	34.61	31.80	28.26	25.27	23.07	21.89	20.64	19.31	17.87	16.32	14.59	13.05	12.63	11.54	11.30	10.32	9.23	8.94	7.99	7.29
84	40.35	34.95	32.11	28.54	25.52	23.30	22.11	20.84	19.50	18.85	16.48	14.73	13.18	12.76	11.65	11.41	10.42	9.32	9.02	8.07	7.37
86	40.76	35.29	32.43	28.82	25.77	23.53	22.33	21.05	19.69	18.23	16.65	14.88	13.31	12.89	11.76	11.53	10.53	9.42	9.11	8.15	7.44
88	41.16	35.65	32.76	29.11	26.03	23.76	22.55	21.26	19.89	18.41	16.81	15.03	13.44	13.01	11.88	11.64	10.63	9.51	9.20	8.23	7.51
90	41.57	36.00	33.08	29.40	26.29	24.00	22.78	21.47	20.09	18.59	16.98	15.18	13.57	13.14	12.00	11.76	10.74	9.61	9.30	8.31	7.59
92	41.99	36.36	33.41	29.69	26.55	24.24	23.00	21.69	20.29	18.78	17.15	15.33	13.71	13.28	12.12	11.88	10.84	9.70	9.39	8.40	7.66
94	42.41	36.73	33.75	29.99	26.82	24.48	23.24	21.90	20.49	18.97	17.32	15.48	13.85	13.41	12.24	12.00	10.95	9.80	9.48	8.48	7.74
96	42.83	37.10	34.09	30.29	27.09	24.73	23.47	22.12	20.70	19.16	17.49	15.64	13.99	13.54	12.37	12.12	11.06	9.90	9.58	8.57	7.82
98	43.26	37.47	34.43	30.59	27.36	27.98	23.70	22.35	20.90	19.35	17.67	15.79	14.13	13.68	12.49	12.24	11.17	10.00	9.67	8.65	7.90
100	43.70	37.84	34.78	30.90	27.63	25.23	23.94	22.57	21.11	19.54	17.85	15.96	14.27	13.82	12.61	12.36	11.29	10.10	9.77	8.74	7.98

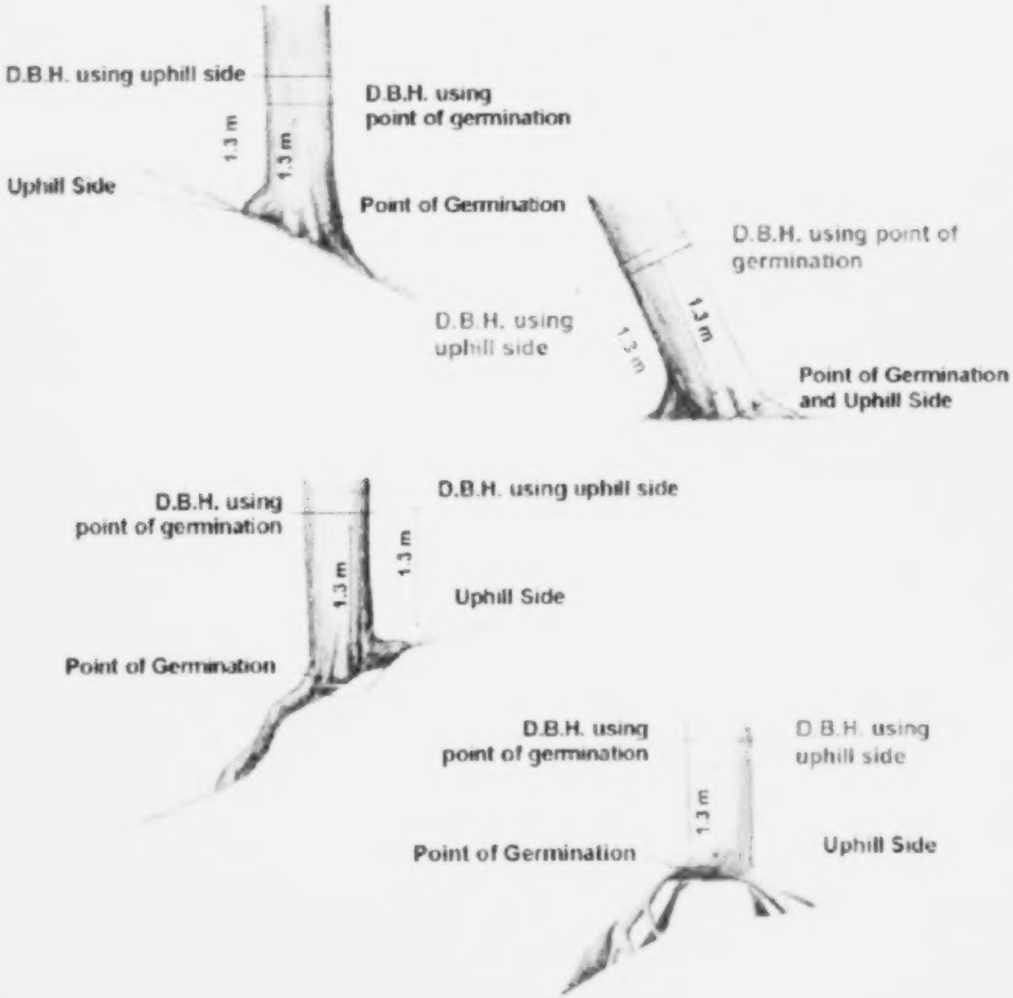
These sub-plot sizes can be measured by holding the tape horizontally

Sub-plot (ha)	0.008	0.007	0.006	0.005	0.004	0.003	0.002
Per Hectare Factor	125.00	142.86	166.67	200.00	250.00	333.33	500.00
Plot Radii (m)	5.05	4.72	4.37	3.99	3.57	3.09	2.52

Appendix 9: Determining Breast Height

Plots established prior to 1991 used the Point of Germination Method

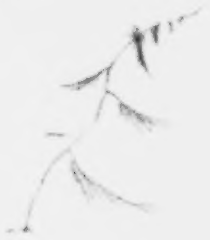
Plots Established After 1990 used the Uphill Side Method


D.B.H. using uphill side
1.3 m
1.3 m
D.B.H. using point of germination
Uphill Side
Point of Germination
D.B.H. using point of germination
D.B.H. using uphill side
1.3 m
1.3 m
Point of Germination and Uphill Side
D.B.H. using point of germination
D.B.H. using uphill side
1.3 m
1.3 m
Uphill Side
Point of Germination
D.B.H. using point of germination
D.B.H. using uphill side
1.3 m
Point of Germination
Uphill Side

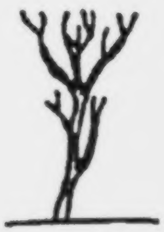
Appendix 10: Special Rules for the Measurement and Classification of Abnormal Trees

Counting and Height Measurement of Abnormal Trees Less than 2.0 cm DBH.

1. Straighten the stem and measure the length from the germination point to the tip of the terminal bud.

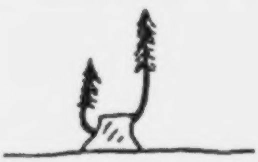


2. Count as one tree and measure the length from the germination point to the tip of the terminal bud on the tallest leader.



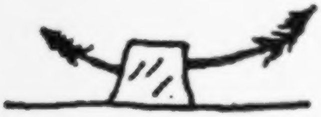
(Temporary Picture)

3. Count as one tree and measure the height from the germination point to the tip of the terminal bud on the tallest leader.



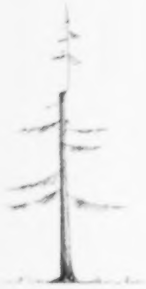
(Temporary Picture)

4. Count as one tree and measure the length of the bole (stump height) from the germination point to the cut.

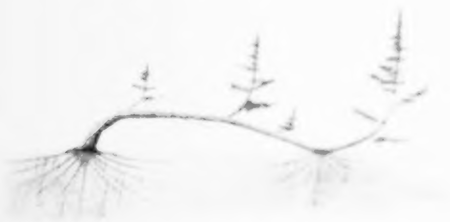


(Temporary Picture)

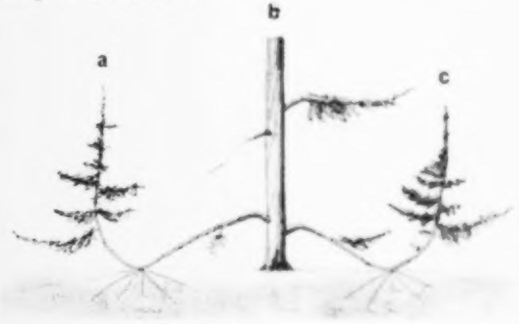
5. Measure the height from the germination point to the tip of the terminal bud on the new leader.



6. Count as two trees (each root system is treated as a tree) and measure the length from each rooting system to the tallest leader.



7. Tag or count as three trees. Measure the length of A and C from the germination point to the tip of the leader.



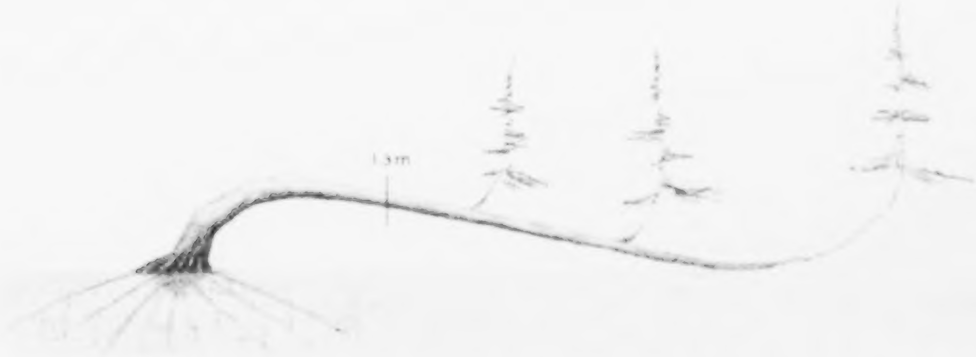
Distinction Between Broken Top and for Trees Greater than 2.0 cm DBH.

1. Classify as broken top until an new leader reaches one metre in length when it will be classified as a fork.

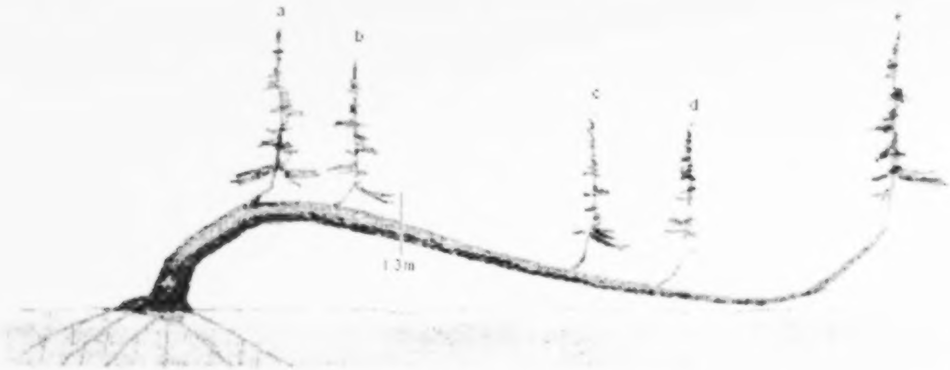
2. Classify as a fork

Trees Greater than 2.0 cm DBH Growing Along the Ground

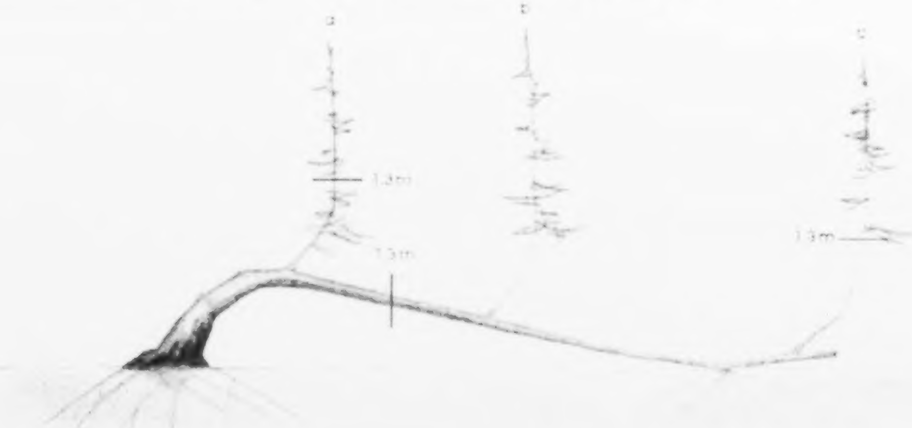
1. One rooting system, tag and record as one tree.



2. One rooting system and one or more trees below breast height A and B are branches which are less than 4.0cm dbh (in plot) or 2.0 cm dbm (in sub-plot), tag and record as a single tree.



3. Two rooting systems and one fork below breast height, tag and record as three trees. A is a fork below DBH and greater than 4.0 cm. B and C have separate rooting systems.



Appendix 11: Pathological Classification of Trees

In mature and older immature stands, the amount of decay that may be present in individual trees can vary considerably. However, reliable estimates of net stand volumes must be obtained. This is accomplished through sampling and through the application of decay reduction factors during sample compilation. But, it must be realized that the correct application of these factors can only be achieved when sampling crews correctly identify and record the presence (or absence) of the decay indicators. This involves the determination of suspect and residual tree classes.

Classes of Trees

All living trees, equal to or greater than 2.0 cm d.b.h. in the sub-plot and 4.0 cm d.b.h. in the plot, are classed as suspect or residual.

Suspect Trees

Suspect trees are living trees which have one or more of the following external indicators of decay on, or immediately adjacent to, the trunk.

1. Conks
2. Blind conks (swollen knots)
3. Scars
4. Fork or pronounced crook
5. Frost crack
6. Trunk infections of mistletoe
7. Rotten branches
8. Dead top
9. Broken top

Note: Classify a tree as suspect on the basis of one or more of the indicators in the preceding list; no other abnormalities are to be used.

Indicators of decay signify decay in the stand rather than in individual trees. The amount of decay indicated varies considerably among species and between individual trees. For example, frost cracks might be highly significant of decay on a particular species in the stand as a whole, but not of individual trees within that stand. On other species within the same stand, frost cracks may not be indicative of decay. However, we must know the occurrence of each indicator of decay before an evaluation can be attempted for any species or stand.

Residual Trees

Residual trees are living trees which bear none of the external indicators of decay listed in "Suspect Trees".

Suspect Indicators of Decay on Standing Trees

A brief description and explanation of the external indicators of decay listed in "Suspect Trees" follows:

Conks

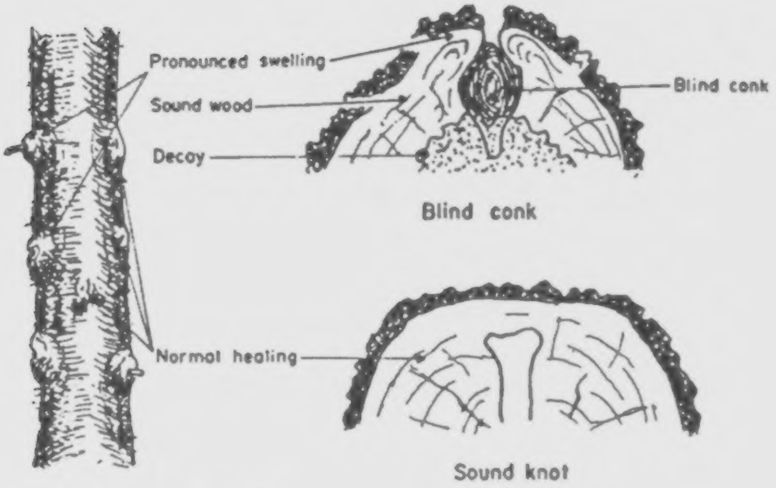
Conks are definite and reliable indicators of decay. They appear most frequently on the underside of dead branch stubs, on branch scars, and on the underside of live branches in the crown of the tree.

Conks vary in size and shape. Consequently, they are hard to spot, particularly when they occur on the upper trunk. Conks of certain fungi, notably *Echinodontium tinctorium* and *Fomes pini*, frequently appear as small hoof-like or shell-like forms on the underside of dead branch stubs on the middle and/or lower trunk of the infected tree.

Moss-covered branch stubs and burls often resemble conks, particularly when viewed from directly below; thus, it is sound practice to view the tree from the side before taking a decision. Remember that conks may appear anywhere on the trunk of an affected tree. Therefore, look for conks on the upper as well as on the lower trunk.

Blind Conks

Blind conks (swollen knots) of Fomes pini are as significant indicators of decay as are conks. Blind conks appear typically as pronounced swellings around knots and are quite different from a normal healed-over sound knot. The swelling results from the tree attempting to heal over an abortive conk or the point from which an old conk has dropped. The swelling is often accentuated by the growing conk which actually pushes out the thick, dead, outer bark of the tree. Often the affected knot is partially covered by sound wood, which is implied by the term "blind" conk. A cut with an axe into a blind conk will reveal the bright yellow or buff colour of the conk (see Figure 1).



Appearance on standing tree

Cross section showing blind conk and a sound knot.

Figure 1. Blind conk and sound knot.

Scars

A scar is any injury, not recent in origin, caused by certain external physical forces or agents, which have exposed the heartwood and/or sapwood of the tree to attack by wood-rotting fungi. We are concerned with scars that signify decay.

Scars are identified as suspect or non-suspect. Suspect scars are indicators of decay whereas non-suspect scars are not, and are not recorded.

Rules

A. Suspect scars may be caused by any of these external physical forces or agents:

1. Fire
2. Lightning
3. Falling trees
4. Logging or other machinery
5. Old blazing
6. Breakage of branches, of secondary leaders, and of suckers from or immediately adjacent to the trunk of the tree caused by wind or heavy snowfall.
7. Animals or birds causing damage to the trunks of trees.

8. Fungi causing cankers on the trunk.
9. Rock slides or falling rocks.
10. Undetermined causes.

Note: Classify cracking of the trunk caused by low extremes of temperature as a frost crack (see Figure 8).

B. Suspect scars caused by the forces or agents listed under A must not be recent or superficial.

These suspect scars are not recent in origin or superficial:

1. Closed scars, that is, scars which have healed (see Figure 3).
2. Open scars or catfaces that show weathered wood (see Figure 4). See the discussion under "Forms of Scars" in this Appendix.

C. Suspect scars can occur anywhere on the trunk of a tree between its germination point and top (see Figure 2).

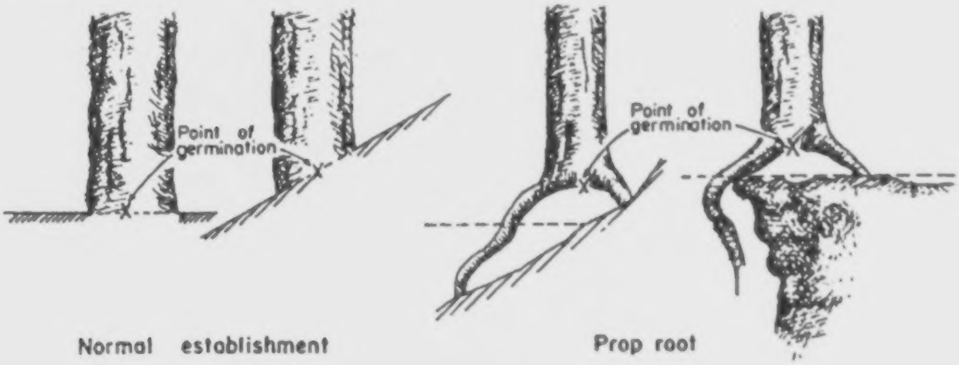


Figure 2. Point of germination.

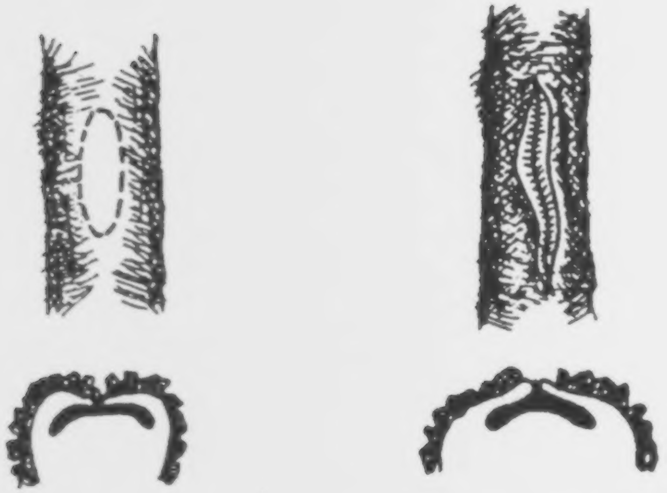
D. Certain physical forces or agents cause superficial scars which are not significant of decay. We are not concerned with this type of non-suspect scar as it is not an indicator of decay.

E. Suspect scars may be of any size.

Forms of Scars

A. Closed scars

A closed scar, which is the result of an early injury that has healed, appears as slight to pronounced indentations of the bark; whereas one that is the result of a more recent injury appears as pronounced scar tissue or callus growth, and often seeps considerable amounts of resin (see Figure 3).



Old healed-over scar

Freshly healed scar

Figure 3. Closed scars.

B. Open scars

Open scars appear as areas of exposed wood of various sizes and shapes. They are the result of severe damage to the tree by fire, lightning, logging, machinery or one of the other causes listed under "Kinds of Scars" in this Appendix.

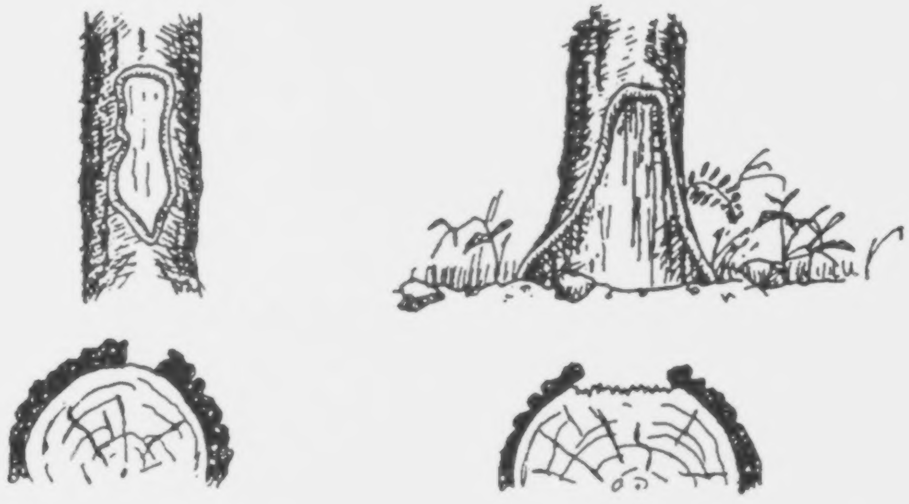
Depending upon the extent and severity of damage to the tree, two types of open scars are recognizable. The first type is the result of damage confined to the bark and cambium layers with little or no damage to the wood, and the appearance and contour of the exposed wood is not appreciably altered. The second type results from extensive damage to the wood and is generally referred to as "catface" (see Figure 4).

Kinds of Scars

A. Old fire scars that have healed over appear typically as slight to pronounced indentations, whereas more recent scars or ones resulting from severe damage appear as open catfaces or hollowings of the trunk.

Fire scars are usually confined to the base of the trunk.

Fire scars are important indicators of decay. In forest stands having a fire history, examine the trees for evidence of them in the form of charred wood within the scar or charring in root crotches and on exposed roots.



Light Damage

Extensive Damage

Figure 4. Open scars.

B. Lightning scars

Lightning causes extensive damage to the trunks and tops of trees. Lightning scars appear typically as narrow to fairly wide strips of torn wood, often extending down the entire length of the tree as a spiral.

C. Falling-tree scars

Trees are frequently scarred by other trees falling against them. Scars of this type are common in selectively cut stands as well as in natural stands. Evidence of this kind of scarring is often a fallen tree against or near to the scarred tree.

D. Logging or other machinery scars

Machinery may cause extensive damage to seed trees, to trees adjacent to logging, and to the trees left after selective cutting. These scars are usually confined to the lower trunk, but they may also occur on the upper trunk when caused by rigging.

E. Old blazing

Old blazes are entry points for wood-rotting fungi. Note that recent blazing is not a suspect scar.

F. Scars caused by breakage of branches, of secondary leaders and of suckers

High winds, heavy snow, and branches falling from adjacent trees can break secondary leaders and suckers from the trunks of trees leaving a scar.

G. Animals and birds

Some animals and birds cause scars which might be suspect. Woodpeckers, bears, deer, rodents, and beavers frequently cause extensive damage to the trunks of trees.

Woodpeckers scar the trunks of trees by making holes of considerable size and depth, which remain open for a long time providing entrance for wood-rotting fungi (see Figure 19).

Sapsucker holes, however, are superficial in extent and are non-suspect (see Figure 19).

Bears, deer, moose and elk sometimes cause extensive damage to the trunks of trees by removing bark and cambium. Scars caused by bear claws are common in many forest stands.

Rodents and beavers also cause severe damage to trees by gnawing on the trunk. Be careful to distinguish between superficial non-suspect damage and suspect damage.

H. Cankers caused by fungi

Cankers caused by fungi kill localized areas of bark and cambium on the trunks of trees. Eventually the dead bark sloughs off exposing the underlying wood. Because of repeated callus growth, cankers ate frequently mistaken for 'mechanical' scars. Cankers are usually flat and elongate and may be indefinite in contour. The exposed wood is often stained and impregnated with resin. Fructifications of the fungus may also be evident (see Figure 5).

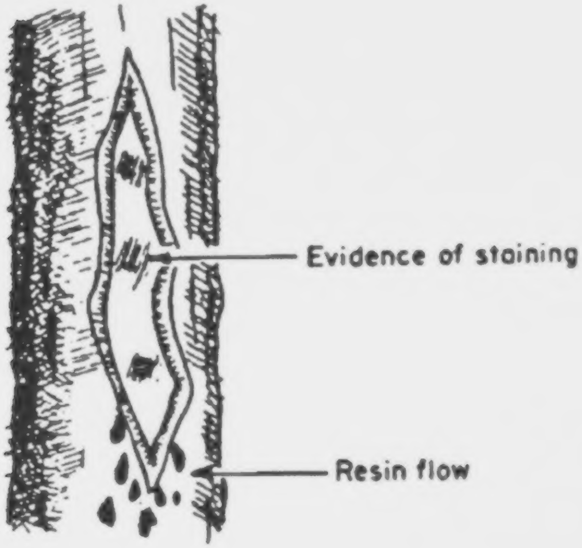


Figure 5. Cankers caused by fungi.

I. Scars caused by rock slides and falling rocks

Rock slides cause extensive damage to trees. Scars caused by rock slides are usually confined to the base of the trunk.

Falling rocks sometimes scar trees at considerable height above the ground because of deep snow or because of the bouncing of the rocks (see Figure 6).

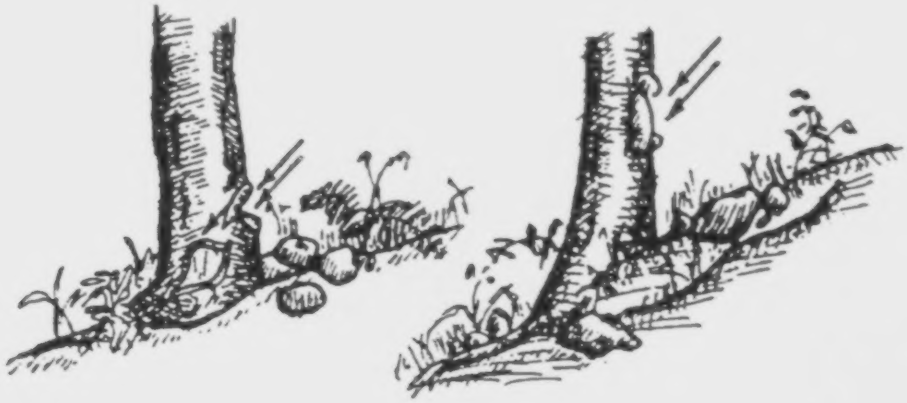


Figure 6. Scars caused by rock slides and falling rocks.

J. Scars of undetermined origin

When it is difficult to ascertain the exact cause of scarring it is essential to adhere to the preceding rules.

Fork or Pronounced Crook

A fork or a pronounced crook between the base and the tip of the tree is a suspect indicator of decay and originates from the development of a secondary leader.

A fork or a crook that develops as the result of an early injury to the top of the tree is a reliable indicator of decay because although the original top may have disappeared or been healed over, the original injury provided an entrance for decay fungi. Usually evidence of the original top is associated with scarring.

Pronounced crook also develops as a result of one of the leaders of a forked tree having broken off.

In Figure 7, A and B illustrate forks in the merchantable part of the trunk. Examples C and D illustrate forks at the base of tree. Example E illustrates non-suspect sucker growth. It is not tallied as a fork. Examples F and G illustrate pronounced crook.

Some forks are non-suspect: for example. those that have formed because of insect or mistletoe attack of the terminal leader and those that are characteristic of the species (yellow pine, and most deciduous species), are not significant of decay.

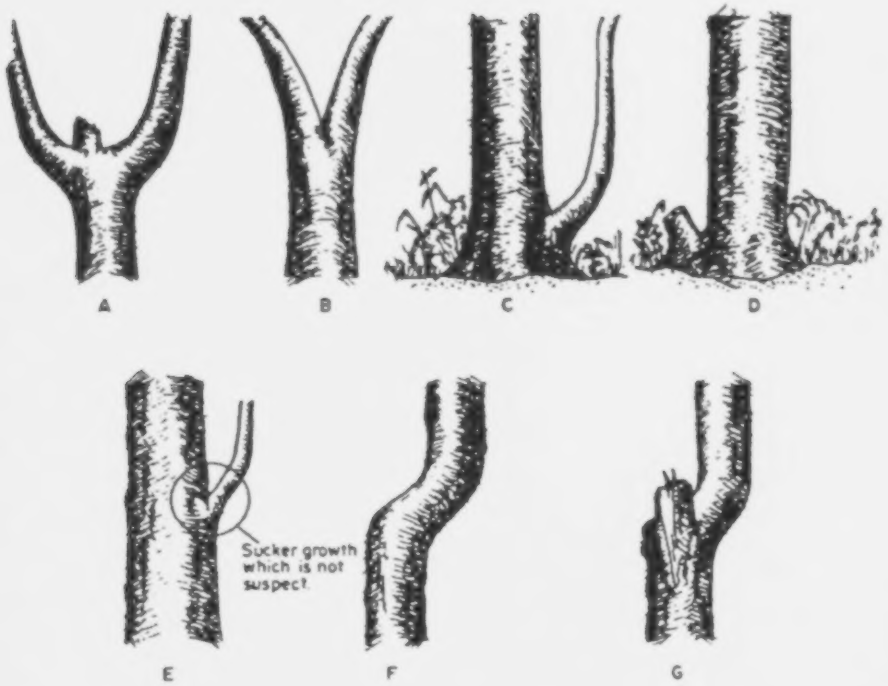

A
B
C
D
Sucker growth which is not suspect
E
F
G

Figure 7. Types of fork and crook (except E).

Frost Cracks

Frost cracks result from deep radial splitting of the trunk caused by uneven shrinkage of the wood after a sudden and pronounced drop in temperature. The cracks usually originate at the base of the trunk and may extend many feet up the tree. Frost cracks are often reopened repeatedly by wind stresses or by low temperatures. Repeated healing of the wood produces considerable callus tissue, giving the wood a pronounced ribbed appearance (see Figure 8).

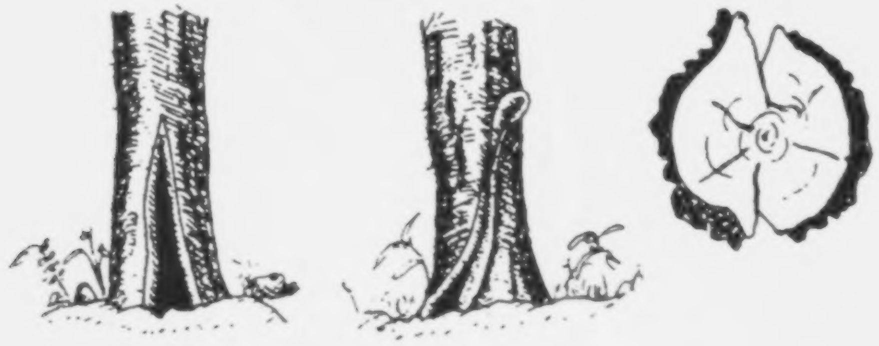


Figure 8. Frost crack on standing trees.

Mistletoe Trunk Infections

Trunk infections of mistletoe are identified by abnormal swelling or malformation of the trunk, or by clusters of dead and broken branches on the trunk or on hypertrophied branches immediately adjacent to the trunk (see Figure 9).

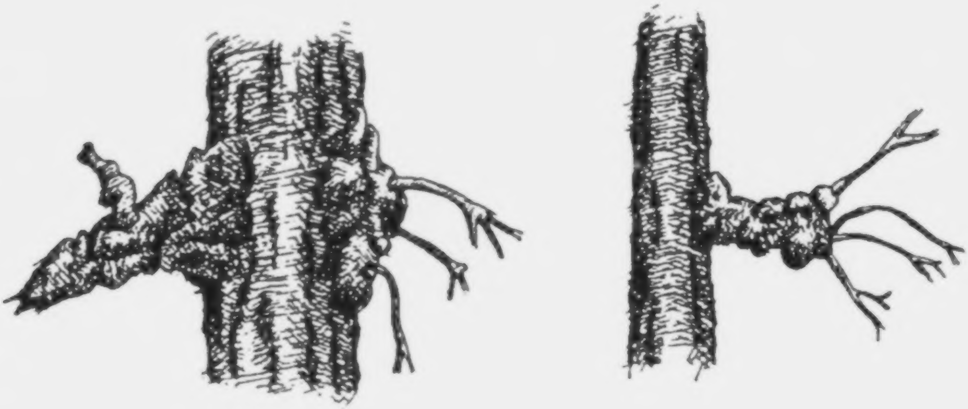
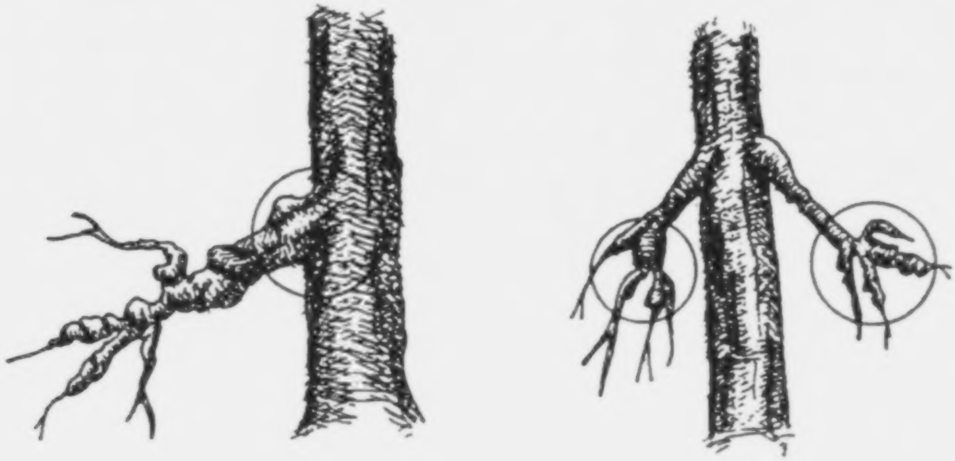


Figure 9. Trunk infections of mistletoe.

Wood-rotting fungi gain entrance to the trunk through the dead hypertrophied branches or through branch stubs where the swelling is on, or adjacent to, the trunk.

For all growth and yield samples, record on the tally sheet any branch or trunk swellings that result from mistletoe infection (see Figure 10).



Branch infection extending to the trunk of the tree

Branch infection not extending to the trunk of the tree

Figure 10. Branch infections of mistletoe.

Rotten Branches

Large, rotten branches, which appear typically on overmature trees, are often indicators of decay in the standing tree. Large branches which are broken off close to the trunk expose a large amount of heartwood to entrance by wood-rotting fungi. Such branches usually appear singly at various points on the trunk, or in groups at some distance below the live crown of the tree.

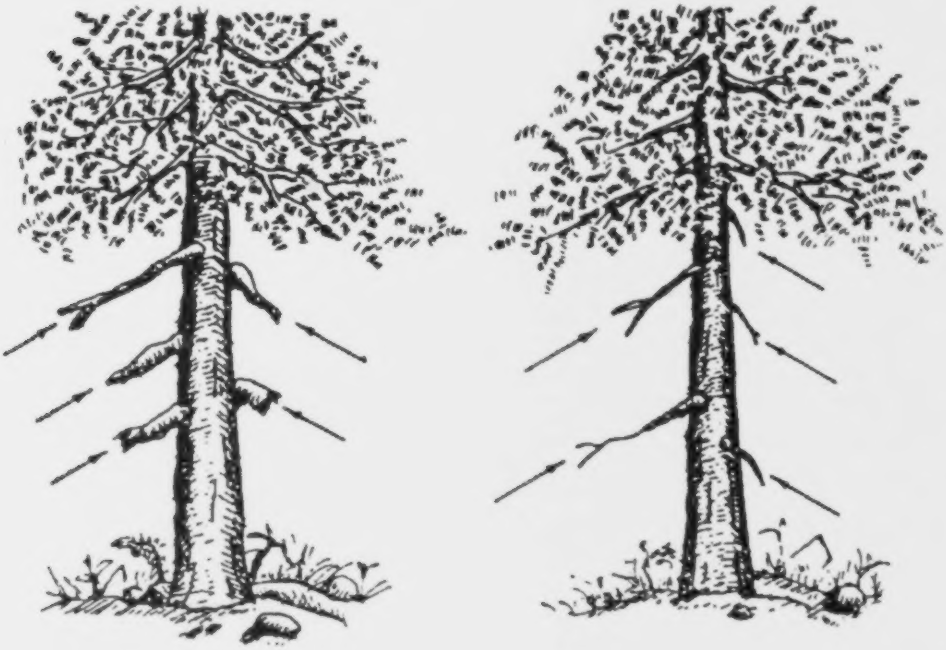
Record only large branches (10 cm or larger in diameter) which are clearly rotten. Do not record small dead branches which appear typically just below the live crown or on the lower trunk of open growing trees (see Figure 11).

Dead Top

Record *only* dead tops that are not recent in origin

Broken Top

Record only broken tops that are not recent in origin; broken tops must be obviously weathered.



Large rotten branches
- suspect -

Small dead branches
- non-suspect -

Figure 11. Rotten branches.

Non-suspect Abnormalities

These abnormalities are not indicators of decay:

External Evidence of Butt Rot Not Associated With Suspect Abnormalities

Butt rot may be evident in exposed roots or within root crotches. However, unless one or more of the suspect abnormalities appears on the tree, do not class the tree as suspect because the butt rot contributes to the decay loss factor associated with the residual tree class.

Flutes

Pronounced flutes on the trunk are characteristic of many species. They do not signify decay (see Figure 12).

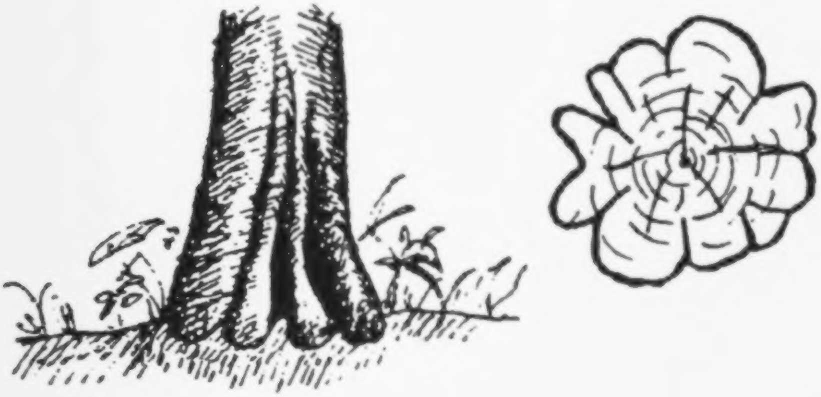


Figure 12. Flutes.

Candelabra Branches

Candelabra branches develop as a result of abnormal branch growth and do not signify decay. they are confused with suspect forking. Note that candelabra branches do not originate in the trunk of a tree as do forks (see Figure 13).

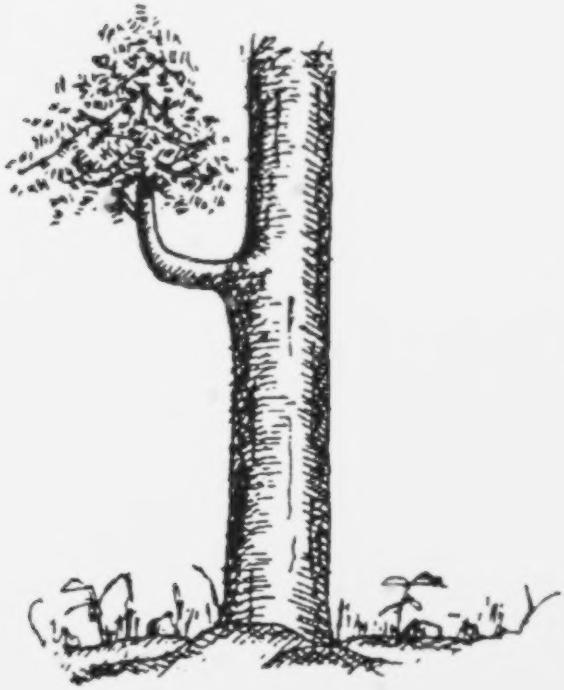


Figure 13. Candelabra branches.

Branch Fans

A branch fan develops through abnormal branching and is not suspect. It appears most commonly as a 'fan' of branches originating from a burl-like swelling on the trunk (see Figure 14).

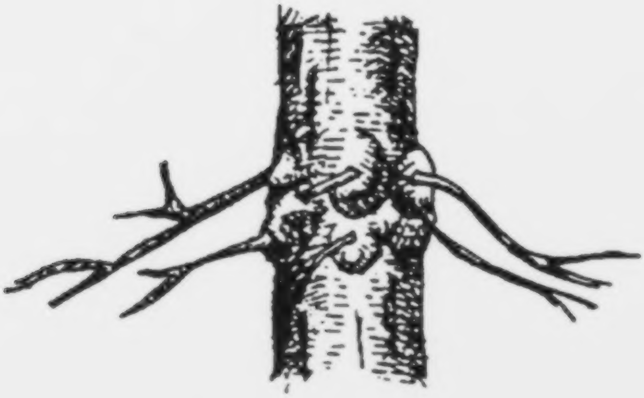


Figure 14. Branch fans.

Black Knots

Black knots frequently develop around unhealed knots and wounds. A superficial saprophytic fungus, which feeds on the exuded sap, causes the blackness. Black knots are quite sound when cut into with an axe and do not signify decay (see Figure 15).

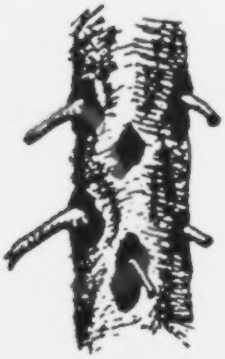


Figure 15. Black knots.

Burls and Galls

Burls and galls develop from abnormal cell growth in trees and although formidable in appearance, do not signify decay (see Figure 16).

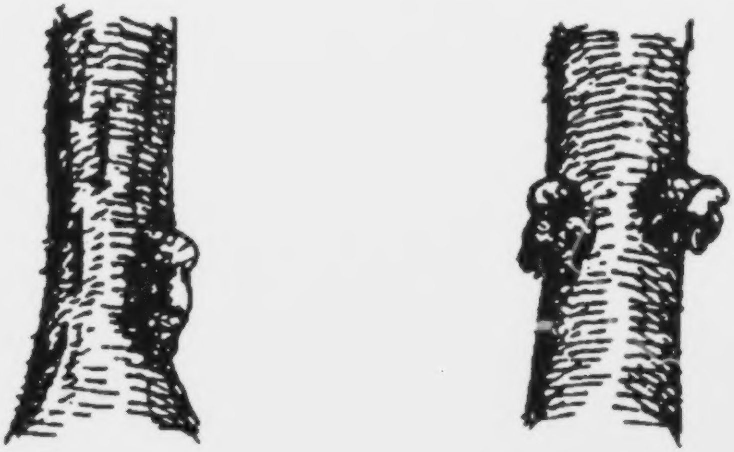


Figure 16. Burls and galls.

Sweep

Sweep which develops as a slight curvature or distortion of the trunk is not significant of decay and is non-suspect (see Figure 17).

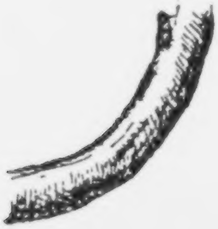


Figure 17. Sweep.

Exposed Roots

Exposed roots and buttress roots do not signify decay unless scarring is present above the point of germination (see Figure 19).

Spiral Grain

Spiral grain is a growth characteristic of some trees and does not signify decay.

Dry Side

Dry side results from the death of the cambium through bruising by other trees or by other physiological causes. Dry side appears as a narrow to wide strip or as a small localized area on the side of a tree. The bark often remains intact over the dead areas. Although dry side may be responsible for the complete rejection, or degrade of a pole tree, it does not signify the presence of decay.

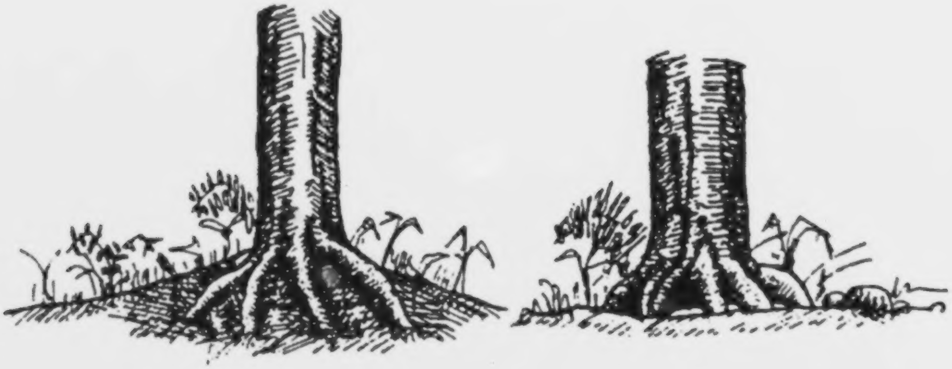


Figure 18. Exposed roots.

Sapsucker Holes

Sapsucker holes are superficial and do not signify decay. Do not confuse the non-suspect scarring of sapsuckers with the suspect scarring of woodpeckers (see Figure 19).

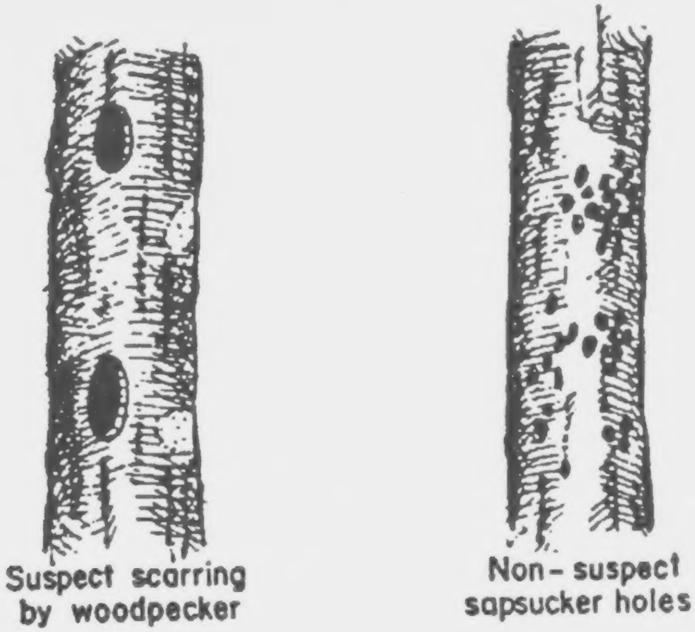

Suspect scarring by woodpecker
Non-suspect sapsucker holes

Figure 19. Sapsucker holes and scarring by woodpeckers.

Insect Borings

Borings by bark beetles or by other insects do not signify decay and are non-suspect.

Appendix 12: Crown Class

1. Crown class 1 (dominant, D)

   Dominant trees having crowns extending above the general level of the crown canopy and receiving full light from above and partly from the side.

2. Crown class 2 (codominant, CD)

   Codominant trees having crowns forming the general level of the crown canopy and receiving full light from above and comparatively little from the sides.

3. Crown class 3 (intermediate, Int)

   Intermediate trees having crowns below, but still extending into, the general level of the crown canopy and receiving little direct light from above but none from the sides.

4. Crown class 4 (overtopped, OT)

   Overtopped trees having crowns below the general level of the crown canopy and receiving no direct light either from above or from the sides.

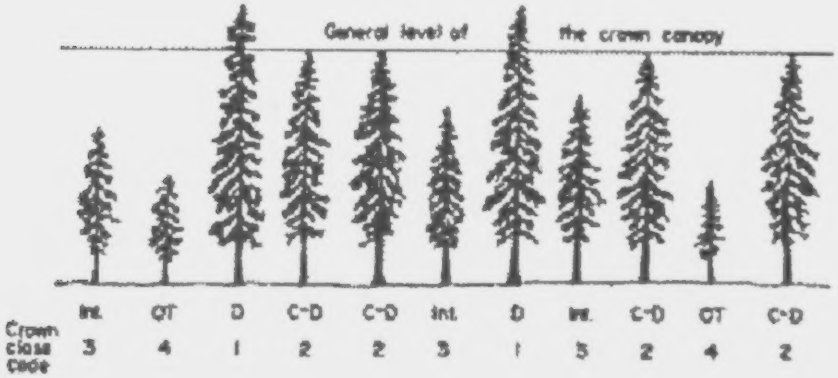
5. Crown class 5 (veteran, VT)

   Veteran trees having large stems and of a much older (40 years) age class than the main stand in an even age stand. Veterans are living remnants of a former stand.

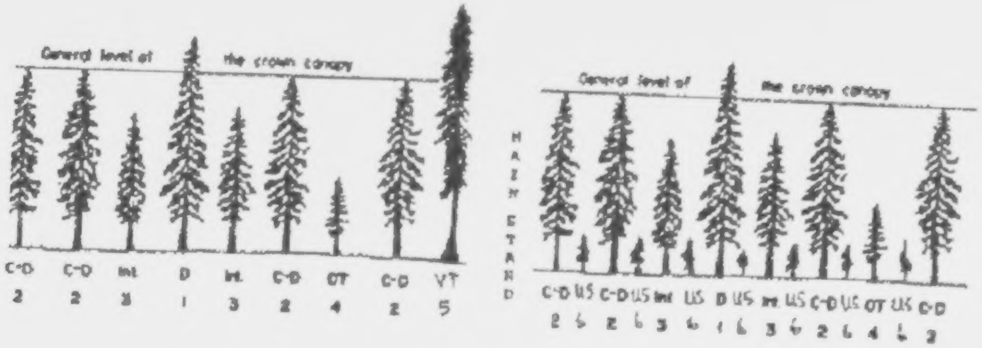
6. Crown class 6 (understory, US)

   Understory trees having a clearly much younger age - usually sapling stage - than the main even-aged stand.

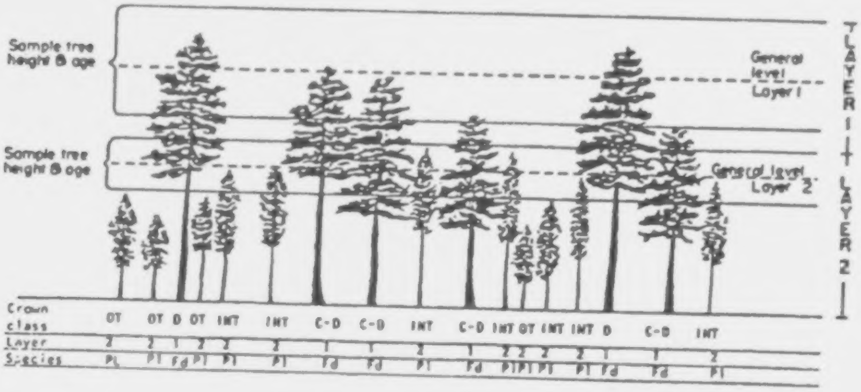
Classify trees with broken tops according to the relative position of the broken top and not to that of the original top.



Crown classes in single-layered stands.


General level of the crown canopy
C-D C-D Int D Int C-D OT C-D VT
2 2 3 1 3 2 4 2 5
MAIN STAND
General level of the crown canopy
C-D US C-D US Int US D US Int US C-D US OT US C-D
2 6 2 6 3 6 1 6 3 6 2 6 4 6 2

Crown Classes in a multi-layered stand.


Sample tree height & age
Sample tree height & age
General level Layer 1
General level Layer 2
LAYER 1
LAYER 2
Crown class
OT OT D OT INT INT C-D C-D INT C-D INT OT INT INT D C-D INT
Layer
2 2 1 2 2 2 1 1 2 1 2 2 2 2 1 1 2
Species
PL Pl Fd Pl Pl Pl Fd Fd Pl Fd Pl Pl Pl Pl Fd Fd Pl

Appendix 13: Stand Structure

Single-layered Stand Structure

Single-layered, simple structure without veterans

The origin of single-layered, simple stands is characterized by a short period of regeneration after a major disturbance or denudation. The tree species may be shade tolerant or intolerant. Tree height varies little, although several height classes may be present because of the differences in growth rates between trees and among species. The distribution of trees by diameter classes is bell shaped.

For a profile of a single-layered, simple stand, see Figure 1

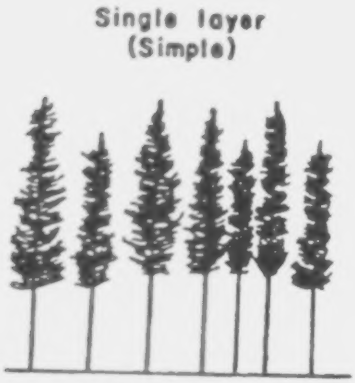


Figure 1. Profile of a single-layered, simple stand.

Single-layered, simple structure with veterans

The stand structure is the same as that described under A but veterans are present.

Fully describe the veteran component for species composition, age, height, and crown closure to the nearest one percent when possible. Do not describe a veteran component in stands older than 120 years except when the leading species is lodgepole pine. However, if a tree is designated as a veteran in a stand < 120 years at establishment, it must remain a veteran even when the stand becomes older than 120 years.

Exceptions for Lodgepole Pine

A veteran component of either Douglas-fir or larch may be included in stands of lodgepole pine if the lodgepole pine is older than 120 years.

Prefix veteran components with a (V) to distinguish them from recognized layers.

Example:

Pl$_{10}$ 122-20.2-5 (Main stand or layer)
(V) Fd$_{10}$ 160-32-03 (Veteran component)

Complex stand structure

The structure of a single-layered, complex stand is characterized by trees of many ages or sizes occurring singly or in groups (see Figure 24). Tree species are usually shade tolerant. Stocking is often patchy and uneven, and the numbers of trees in each size class decrease as diameters increase. The term, complex structure, is intended to describe stands with atypical and unpredictable variations. Examples are partially disturbed stands of interior dry-belt Douglas-fir and yellow pine, and residual stands of spruce-balsam after logging.

Do not describe old growth climax stands as complex, because variations in stand structure are normal and predictable.

Complex stand structure with veterans

The stand structure is the same as that described under a complex stand structure but veterans are present. Fully describe the veteran component for species composition, age, height, and crown closure to the nearest one percent when possible.

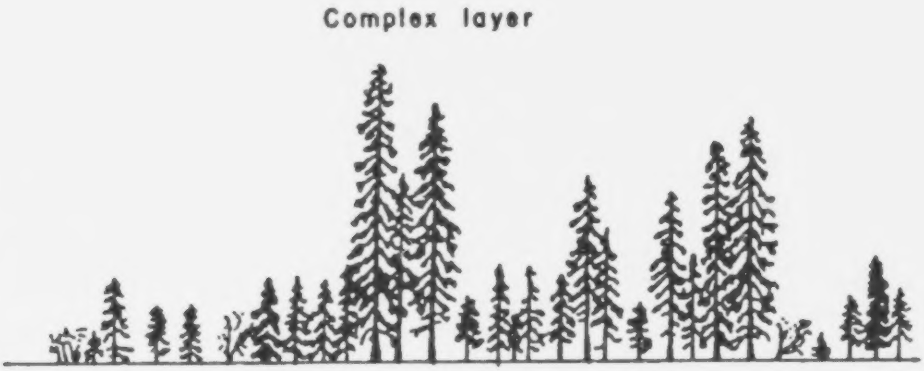


Figure 2. Profile of a single-layered, complex stand.

To describe complex layer:

A. Treat the stand as one heterogeneous layer.

B. Vertically stratify the stand into three equal zones (upper, middle and lower).

C. Provided that the crown closure for the upper zone is greater than or equal to 6 percent, select the required representative sample trees for age and height measurements from the upper zone and average them for the stand.

D. If crown closure for the upper zone is less than six percent, include the top portion of the middle zone to raise the crown closure to six percent or greater before selecting sample trees for measurement.

E. Estimate crown closure for the type for all stems in the main canopy.

F. When assigning a label to the sample, show the age variation in brackets after the stand age.

Example:

B_{10} 95(40/120)
Age Age variation

Multi-layer Stand Structure

Note: Do not establish growth natural samples in multi-layered stands except in Forest Districts in which this type of stand structure is prominent.

A multi-layered stand (see Figure 3) has two distinct layers that can be recognized on the medium-scale photographs used for forest stratification.

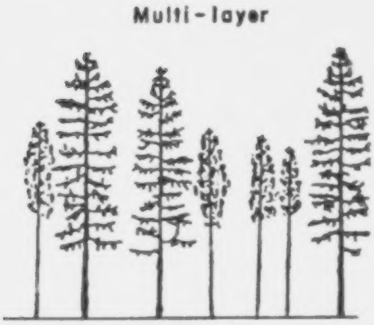


Figure 3. Multi-layered Stand.

The multi-layer classification must be used with caution. Such stands are difficult to sample and to characterize for volume, density and species composition by layer. Unless the difference between the layers is distinct then classify and sample as a single layer. For example, a climax stand of spruce-balsam with an understorey of balsam-spruce should be classified as a single layer whereas a young lodgepole stand established after a fire under an old growth layer of Douglas-fir is best described by two layers.

To be classified as multi-layered, a stand must satisfy the following criteria based upon an assessment of the medium-scale forest classification photographs:

A. Each layer must be distinct and relatively homogeneous throughout the type.

B. Each layer should consist of different species except for a layer of regeneration or samplings under a volume component.

C. Differences in age and height between layers should be at least 40 years and approximately 10 metres, respectively.

D. Estimated crown closure for each layer must be six percent or greater, except for a very young layer when 750 stems per hectare or greater is the criterion used.

E. The bottom layer was normally established as a result of a major disturbance such as fire or logging.

F. With one exception, the age of the younger of the two layers must always be 120 years or less. Thus, if both layers are 121 years or older, treat them as one layer.

Exception: If one layer is predominantly lodgepole pine, 121 years or older, and the second is a much older layer of Douglas-fir or larch, then classify and describe the stand as multi-layered.

Example:

L_{10} 260 - 33.0 - 1 (layer 1)
Pl_{10} 130 - 26.0 - 5 (layer 2)

For examples of two common multi-layered stands, see Figure 4 and 5.

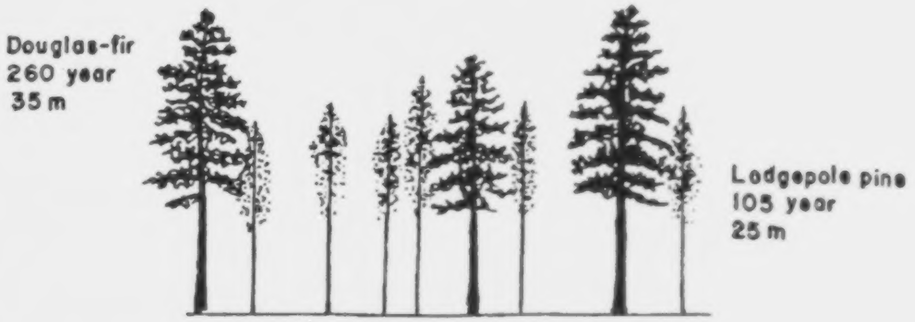


Figure 4. A 260-year old layer of Douglas-fir with a 105-year old layer of lodgepole pine.

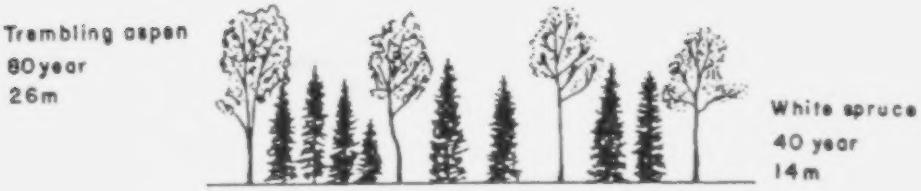


Figure 5. A 40-year old stand of white spruce with an 80-year old overstorey of trembling aspen.

To describe multi-layered stands:

A. Stratify the type into two distinct layers (top and bottom) and consider each one as a unique entity.

B. Select representative sample trees in each layer according to previously defined guidelines for simple layers.

C. Fully describe each layer for species composition, age, height, crown closure, and density if it is available from measured samples.

D. Always describe and label from the top layer down (only the most important layer will be shown on the published map).

E. Rank the relative importance of each layer based on regional guidelines, and indicate and bracket the rank in front of the description. The layer with the highest rank will be the basis for sample allocation.

F. Unless otherwise directed, do not describe a veteran component in a multi-layered stand. Example:

Rank
(2) S_7B_3 200-32.0-1 (Top layer)
Most important layer (1) $Pl_4\ S_3\ B_3$ 40-10.0-4 (Bottom layer)
↑ ↑ ↑ ↑
Sp. comp. Age Ht. C.C.

Appendix 14: Damage Agents and Severity Codes

I. Damage Agents

Acceptable Codes	Description	Scientific Name
A	**Animal Damage**	
AB	Bear	
AC	Cattle	
AD	Deer	
AE	Elk	
AH	Hare or rabbit	
AM	Moose	
AP	Porcupine	
AS	Squirrel	
AV	Vole	
AX	Birds	
AZ	Beaver	
C	**Cone and Seed Insects**	
CAH	Cone resin midge	(Asynapta hopkinsi)
CBC	Fd cone moth	(Barbara colfaxiana)
CBX	Fir cone moth	(Barbara sp.)
CCP		(Camptomyia pseudotsugae)
CDC	Sx cone gall midge	(Dasineura canadensis)
CDD	Fir seed midge	(Dasineura abiesemia)
CDR	Sx cone axis midge	(Dasineura rachiphaga)
CDX	Dasineura midges	(Dasineura spp.)
CEA	Fir cone maggot	(Earomyia abietum)
CEB		(Earomyia babara)
CEQ		(Earomyia aquilonia)
CEX	Earomyia maggots	(Earomyia spp.)
CFP	Fd cone beetle	(Emobius Punctulatus)
CHX	Budworms	(Choristoneura spp.)
CIA	Fir coneworm	(Dioryctria abietivorella)
CIP	Fd coneworm	(Dioryctria psuedotsugella)
CIR	Sx coneworm	(Dioryctria reniculelloides)
CIS	Pine coneworm	(Dioryctria rossi)
CIV	Py coneworm	(Dioryctria auranticella)
CIX	Coneworms	(Dioryctria spp.)
CLO	Western conifer seed bug	(Leptogiossus occidentalis)
CMA	Py seed chalcid	(Megastigmus albifrons)
CMC	Sx seed chalcid	(Megastigmus piceae)

Acceptable Codes	Description	Scientific Name
CML	Bl seed chalcid	(Megastigmus lasiocarpae)
CMP	Fir seed chalcid	(Megastigmus pinus)
CMR		(Mestigmus rafni)
CMS	Fd seed chalcid	*(Mestigmus spermotrophus)*
CMT	Hw seed chalcid	(Megastigmus tsugae)
CMX	Seed chalcids	(Megastigmus spp.)
CNP	Pine cone beetle	(Conophthorus ponderosae)
CPS		(Pineus similis)
CRX	Cone scale midges	(Resseliella spp.)
CSN	Spiral spruce cone borer	(Strobilomyia neanthracina)
CTO	Fd cone gall midge	(Contarinia oregonensis)
CTW	Fd cone scale midge	(Contarinia washintonensis)
CVP	Pw cone borer	(Eucosma ponderosa)
CVR	Pl cone borer	(Eucosma recissoriana)
CYC	Sx seed midge	(Mayetiola carpophaga)
CYP	Py seedworm	(Cydia piperana)
CYS	Sx seedworm	(Cydia strobilella)
D	**Diseases**	
DB	Broom rust	
DBF	Fir broom rust	(Melampsorella caryophyliacearum)
DBS	Spruce broom rust	(Chrysomyxa arctostaphyli)
DD	**Stem rot**	
DDB	Birch trunk rot	(Fomes fomentarius)
DDD	Sulfur fungus	(Laetiporus sulphureus)
DDE	Rust red stringy rot	(Echinodontium tinctorium)
DDF	Brown crumbly rot	(Fomitopsis pinicola)
DDH	Hardwood trunk rot	(Phellinus ignarius)
DDO	Cedar brown pocket rot	(Poria sericeomollis)
DDP	Red ring rot	(Phellinus pini)
DDQ	Quinine conk rot	(Fomitopsis officinalis)
DDS	Schweinitzii butt rot	(Phaeolus schweinitzii)
DDT	Aspen trunk rot	(Phellinus tremulae)
DF	**Foliage Disease**	
DFA	Western pine aster rust	(coleosporium asterum)
DFC	Large spored spruce-labrador tea rust	(Chrysomyxa ledicola)
DFD	Spruce needle cast	(Lirula macrospora)
DFE	Elytroderma needle cast	(Elytroderma deformans)
DFH	Larch needle cast	(Hypodermella laricis)
DFL	Pine needle cast	(Lophodermella concolor)
DFM	Larch needle blight	(Meria laricis)
DFP	Fir fireweed rust	(Pucciniastrum epiobi)
DFR	Douglas-fir needle cast	(Rhabdocline pseudotsugae)
DFS	Red band needle blight	(Mycosphaerella [Sirrhia] pini)
DL	**Disease-caused dieback of leader**	

Acceptable Codes	Description	Scientific Name
DLD	Dermea canker	(Dermea pseudotsugae)
DLF	Red flag disease	(Potebniamyces balsamicola)
DLP	Phomopsis canker	((phomopsis lokoyae)
DLS	Sydowia (Sclerophoma) tip dieback	(Sclerophoma pithyophila)
DLV	Aspen-poplar twig blight	(Venturia spp.)
DM	**Dwarf Mistletoe**	
DMF	Douglas-fir mistletoe	(Arceuthobium douglasii)
DMH	Hemlock dwarf mistletoe	(Arceuthobium tsugense)
DML	Larch dwarf mistletoe	(Arceuthobium laricis)
DMP	Lodgepole pine dwarf mistletoe	(Arceuthobium americanum)
DR	**Root Disease**	
DRA	Armillaria root disease	(Armillaria ostoyae)
DRB	Black Stain root disease	(Leptographium wageneri)
DRC	Laiminated root rot (cedar strain)	(Phellinus weirii)
DRL	Laminated root rot	(Inonotus sulphurascens)
DRN	Annosus root disease	(Heterobasidion annosum)
DRR	Rhizina root disease	(Rhizina undulata)
DRT	Tomentosus root rot	(Inonotus tomentosus)
DS	**Stem Diseases (Cankers & Rusts)**	
DSA	Atropellis canker (Lodgepole pine)	(Atropellis piniphila)
DSB	White pine blister rust	(Cronartium ribicola)
DSC	Comandra blister rust	(Cronartium comandrae)
DSE	Sooty bark canker	(Encoelia pruinosa)
DSG	Western gall rust	(Endocronartium harknessii)
DSH	Hypoxylon canker	(Hypoxylon mammatum)
DSP	Cryptosphaeria canker	(Cryptosphaeria populina)
DSR	Ceratocystis canker	(Ceratocystis fimbriata)
DSS	Stalactiform blister rust	(Cronartium coleosporioides)
DST	Target canker	(Nectria galligena)
DSY	Cytospora canker	(Cytospora chrysosperma)
I	**Insects**	
IA	Aphids or adelgids	
IAB	Balsam woolly adelgid	(Adelges piceae)
IAC	Giant conifer aphid	(Cinara spp.)
IAG	Cooley spruce gall adelgid	(Adelges cooleyi)
IAL	Western larch cone woolly aphid	(Adelges lariciatus)
IAS	Green spruce aphid	(Elatobium abietinum)
IB	**Bark Beetles**	
IBB	Western balsam bark beetle	(Dryocetes confusus)
IBD	Douglas-fir beetle	(Dendroctonus pseudotsugae)

Acceptable Codes	Description	Scientific Name
IBI	Engraver beetles	(Ips spp.)
IBM	Mountain pine beetle	(Dendroctonus ponderosae)
IBP	Twig beetles	(Pityogenes, pityophthorus spp.)
IBS	Spruce beetle	(Dendroctonus rufipennis)
IBT	Red turpentine beetle	(Dendroctonus valens)
IBW	Western pine beetle	(Dendroctonus brevicomis)
ID	**Defoliating Insects**	
IDA	Black army cutworm	(Actebia fennica)
IDB	2-year budworm	(Choristoneura biennis)
IDC	Larch casebearer	(Coleophora laricella)
IDD	Western winter moth	(Erannis tiliaria vancouverensis)
IDE	Spruce budworm	(Choristoneura fumiferana)
IDF	Forest tent caterpillar	(Malacosoma disstria)
IDG	Greenstriped forest looper	(Melanolophia imitata)
IDH	Western blackheaded budworm	(Acleris gloverana)
IDI	Pine needle sheath miner	(Zellaria haimbachi)
IDL	Western hemlock looper	(Lambdina fiscellaria lugubrosa)
IDM	Gypsy moth	(Lymantria dispar)
IDN	Birch leaf miner	(Fenusa pusilla)
IDP	Larch sawfly	(Pristophora erichsoni)
IDR	Alder sawfly	(Eriocampa ovata)
IDS	Conifer sawfly	(Neodiprion spp.)
IDT	Douglas-fir tussock moth	(Orgyia pseudotsugata)
IDU	Satin moth	(Leucoma salicis)
IDV	Variegated cutworm	(Peridroma saucia)
IDW	Western spruce budworm	(Choristoneura occidentalis)
IDX	Large aspen tortix	(Choristoneura conflictana)
IDZ	Western false hemlock looper	(Nepytia freemani)
IS	**Shoot Insects**	
ISB	Western cedar borer	(Trachykele blondeli)
ISE	European pine shoot moth	(Rhyaconia buoliana)
ISG	Gouty pitch midge	(Cecidomyia piniinopis)
ISP	Pitch nodule moths	(Petrova spp.)
ISQ	Sequoia pitch moth	(Vespamima sequoiae)
ISS	Western pine shoot borer	(Eucosma sonomana)
IW	**Weevils**	
IWC	Conifer seedling weevil	(Steremnius carinatus)
IWM	Magdalis species	(Magdalis spp.)
IWP	Lodgepole pine terminal weevil	(Pissodes terminalis)
IWS	White pine weevil (on spruce)	(Pissodes strobi)
IWW	Warren's root collar weevil	(Hylobius warreni)
IWY	Cylindrocopturus weevil	(Cylindrocopturus spp.)
IWZ	Yosemite bark weevil	(Pissodes schwartzii)

Acceptable Codes	Description	Scientific Name
M	**Mite Damage**	**(Trisetacus spp.)**
N	**Non-biological (Abiotic) Injuries**	
NB	Fire	
ND	Drought	
NF	Flooding	
NG	Frost	
NGC	Frost crack	
NGH	Frost heaved	
NGK	Shoot/bud frost kill	
NH	Hail	
NK	Fumekill	
NL	Lightning	
NN	Road salt	
NR	Redbelt	
NS	Slide	
NW	Windthrow	
NWS	windthrow - soil failure	
NWT	windthrow - treatment or harvested related	
NX	Scarring/rubbing	
NY	Snow or ice (includes snow press)	
NZ	Sunscald	
P	**Cone and Seedling fungal Pathogens**	
PAX		(Alternaria spp.)
PBC	Gray mould	(Botrytis cinera)
PCD		(Cylindrocarpon destructans)
PCF	Seed or cold fungus	(Caloscypha fulgens)
PCP	Inland spruce cone rust	(Chrysomyxa pirolata)
PDT	Cedar leaf blight	(Didymascella thujina)
PFX		(Fusarium spp.)
PPG	Damping-off disease	(Phoma glomerata)
PPX		(Penicillium spp.)
PSS	Sirococcus blight	(Sirococcus strobilinus)
PTX		(Trichothecium spp.)
T	**Treatment Injuries**	
TC	Chemical	
TH	Harvested	
TL	Logging	

Acceptable Codes	**Description**	**Scientific Name**
TM	Other chemical damage (non-logging)	
TP	Planting	
TPM	Poor planting microsite	
TR	Pruning	
TT	Thinning or spacing wound	
V	**Problem Vegetation**	
VH	Herbaceous competition	
VP	Vegetation press	
VS	Shrub competition	
VT	Tree competition	

II. Damage Severity and Mortality Condition Codes

Damage Code	Damage/Condition Or agent	Severity Code	Code description and Classification
A's	Mammals, birds, and root collar weevil (girdlers)	Enter % 1=10%, 10=100%	Record % girdle
C, DD, DL, IA, N, P, T, and V	Cone/seed insects and fungal pathogens, Abiotic	Subjective Rating	
		L	Low
		M	Moderate
		S	Severe
DB, DM	Broom rust and Dwarf mistletoe	Enter one of 1,2,3,4,5,6 and	See Fig. 1 for Hawkworth's 6-class rating system for all species and for **coastal western hemlock**:
		N	Minor stem swelling
		M	Major stem swelling
DR	Root Rots	W5	Within 5 m of *A. Ostoyae* infection source
		LC	Light Crown symptons
		SC	Severe Crown symptons
		RL	Basal resinosis (Light) ≤ 50% circumference
		RS	Basal resinosis (Severe) > 50% circumference
		BR	Butt Rot
		CS	Confirmatory Symptoms: stain, decay, mycelia, rhizomorphs, or sporophores
DS	Stem rusts	BC	Branch Canker(s)
		SC	Stem Canker(s)
		TK	Top-kill
IB	Bark Beetle	FA	Failed Attack
		GR	Current (Green) attack
		RA	Red Attack
		GY	Grey Attack
ID, DF, M	Defoliators, Mites, needle rusts, and blight	Enter % defoliated 1=10%, 10+100%	Record % defoliated, discoloured, or infected **(past and present attacks)**
IDW	Defoliators Western Spruce Budworm	Enter % defoliated 1=10%, 10=100%	Record % **current year's foliage**, bud and or shoot destruction
IS, IW	Terminal weevils	Enter # of attacks (1-9) And	Record # of years of attacks (1 – 9)
		M	Major crook
		N	Minor crook
		F	Forking
		S	Staghead

Appendix 15: Quality Assurance Report

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REPORT No: 8                    MSRM - Terrestrial Information Branch                       Page:1
 Vers 2002(2002.06.01)      Data Collecting, Editing and Reporting System                Q.A. REPORT
2002 Aug 14                          Reg  Comp  Let  Inst  Sample  Type
10:51:05                              55   18          0      1      G

Measurement# 4   Meas.Date:2002-07-03         Crown Closure, Layer 1:60  (_____)  Layer 2/V:0   (_____)

Species Comp:    Lyr : PL=94.2 AT=3.4 S=2.3 BL=0.2

Stem Map?:N  Plot Centre Offset?:N  Bearing from Compass to PlotCentre:0    Slope:0    Slope Dist:0.00
Plot Area:0.0810  Radius:16.06        Lgth:0.00      Width:0.00       Sub-Plot Area:0.0810   Radius:16.06

Plot#:1  Aspect:230 (_____)    Slope:4    (_____)    Elev:884  (______)   Slope Pos:M (_______)
       T/L Bear:0    (_____) T/L Dist:0.0    (_______)

DBH SAMPLE TREES:
--------------------------------------------------------------------------------------------------------
L S M Tre|-Sector-    DBH| Dia TC|- Path - | Ht  S Br Wld|CC  LC%  |  Ht  S  Sw|DmAgt1 DmAgt2 Near  Miss
Y u #  No|CsTs Ss Sp 1.3M|1.37M  |fscdbcmbr| Bk  D Tp App|  Est Msd|      t Ln |TAg Sv TAg Sv Tree  Dr/F
--------------------------------------------------------------------------------------------------------
    3  18|   2  0 PL 24.1|  0.0 2|210000000|      0   0 |2  30   0| 23.1 H 0 0|                 17
  Y 4    |   2  1 PL 26.4|  0.0 2|210000000|      0   0 |2  30   0| 24.4 D 0 0|                 17
________________________________________________________________________________________________________
    3  66|   0  0 PL 12.7|  0.0 4|000000000|      0   0 |0   0   0|  0.0   0 0|                 65
  N 4    |   6  4 PL 12.7|  0.0 4|000000000|      0   0 |0   0   0|  0.0 N 0 0|                 65
________________________________________________________________________________________________________
    3 104|   8  0 PL 21.1|  0.0 2|200000000|      0   0 |2  30   0| 21.3   0 0|                103
  Y 4    |C  8  5 PL 24.7|  0.0 2|100000000|      0   0 |2  40   0| 23.0 H 0 0|                103
________________________________________________________________________________________________________
    3 106|   8  0 PL 18.4|  0.0 2|310000000|      0   0 |2  40   0|  0.0   0 0|DSG 10          105
  Y 4    |   8  5 PL 20.0|  0.0 2|310000000|      0   0 |2  40   0|  0.0 O 0 0|DSG BC          105
________________________________________________________________________________________________________
    3 107|   8  0 PL 16.1|  0.0 2|110000000|      0   0 |2  20   0| 20.4   0 0|                106
  Y 4    |   8  5 PL 17.5|  0.0 2|110000000|      0   0 |2  20   0| 21.1 M 0 0|                106
________________________________________________________________________________________________________
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REPORT No: 8                        MSRM - Terrestrial Information Branch                    Page:2
2002 Aug 14                            Reg  Comp  Let  Inst  Sample  Type
10:51:05                                55   18          0      1      G

DBH SAMPLE TREES:
------------------------------------------------------------------------------------------------------------
L S M Tre|-Sector-     DBH| Dia TC|- Path - | Ht   S Br Wld|CC   LC%   |  Ht   S  Sw|DmAgt1 DmAgt2 Near  Miss
Y u #  No|CsTs Ss Sp 1.3M|1.37M  |fscdbcmbr| Bk   D Tp App|   Est Msd|       t Ln |TAg Sv TAg Sv Tree  Dr/F
------------------------------------------------------------------------------------------------------------
    3 109|   9  0 PL 13.5|  0.0 4|000000000|        0    0 |0    0    0|  0.0    0 0|D R  L          108
  N 4    |   9  6 PL 13.5|  0.0 4|000000000| 3.5 S 0    6 |0    0    0|  0.0 N 0 0|                108
         |               |       |         |              |           |           |
____________________________________________________________________________________________________________
    3 111|   9  0 PL 11.0|  0.0 2|520000000|        3    0 |2   10    0|  0.0    0 0|DSG 30          110
  C 4    |   9  6 PL 12.0|  0.0 2|420000000|        0    0 |3   10    0| 11.8 M 0 0|DSG BC          110
         |               |       |         |              |           |           |
____________________________________________________________________________________________________________
    3 192|  11  0  S  4.5|  0.0 1|000000000|        0    0 |4   80    0|  0.0    0 0|IAG  S          143
  Y 4    |  11  8  S  4.9|  0.0 1|000000000|        0    0 |4   80    0|  4.8 M 0 0|IAG  S          143
         |               |       |         |              |           |           |
____________________________________________________________________________________________________________
  Y 4 300|   7  5 BL  3.5|  0.0 1|000000000|        0    0 |4   70    0|  3.1 M 0 0|                126
         |               |       |         |              |           |           |
____________________________________________________________________________________________________________

HEIGHT SAMPLE TREES:
------------------------------------------------------------------------------------------------------------
L S M Tree|-Sector-      DBH| Dia TC| Height Readings                        |BH  Bor          |Radial Inc.   |Near
Y u #   No|CsTs Ss Sp  1.3M|1.37M  |Top Bot Tot SDst Slp Ht   Cor TotHt|Age Ht Pith Sup|5yr 10yr 20yr|Tree
------------------------------------------------------------------------------------------------------------
    3   18|   2  0 PL  24.1|  0.0 2| 84  -3  81    0 25.0 21.8 1.3 23.1|                | 0    0     0|  17
  Y 4     |   2  1 PL  26.4|  0.0 2|  0   0   0    0  0.0 23.1 1.3 24.4|                | 0    0     0|  17
          |                |       |                                    |                |              |
____________________________________________________________________________________________________________
    3  104|   8  0 PL  21.1|  0.0 2| 84   4  88    0 25.0 20.0 1.3 21.3|  0 0.00        | 0    0     0| 103
  Y 4     |C  8  5 PL  24.7|  0.0 2|  0   0   0    0  0.0 21.7 1.3 23.0|102 1.30 Y    N | 6   12    25| 103
          |                |       |                                    |                |              |
____________________________________________________________________________________________________________
```

```
REPORT No: 8                    MSRM - Terrestrial Information Branch                      Page:3
2002 Aug 14                       Reg  Comp  Let  Inst  Sample  Type
10:51:05                           55   18          0      1     G

HEIGHT SAMPLE TREES:
--------------------------------------------------------------------------------------------------------
L S M Tree|-Sector-      DBH| Dia TC| Height Readings                       |BH  Bor          |Radial Inc.  |Near
Y u #   No|CsTs Ss Sp  1.3M|1.37M  |Top Bot Tot SDst Slp Ht   Cor TotHt|Age Ht Pith Sup|5yr 10yr 20yr|Tree
--------------------------------------------------------------------------------------------------------
    3  107|    8  0 PL  16.1|  0.0 2| 82  -1  81    0 23.0 19.1 1.3 20.4|  0 0.00         |  0    0    0| 106
  Y 4     |    8  5 PL  17.5|  0.0 2|  0   0   0    0  0.0 19.8 1.3 21.1| 94 1.30 Y       |  5    9   18| 106
          |                 |       |                                   |                 |             |
________________________________________________________________________________________________________
    3  112|    9  0 PL  12.5|  0.0 2|  0   0   0    0  0.0 -1.3 1.3  0.0|  0 0.00         |  0    0    0| 111
  C 4     |    9  5 PL  15.0|  0.0 2|  0   0   0    0  0.0 12.6 1.3 13.9|  0 0.00         |  0    0    0| 111
          |                 |       |                                   |                 |             |
________________________________________________________________________________________________________
    3  156|    1  0 AT   9.0|  0.0 1| 76   3  79    0 15.0 11.0 1.3 12.3|  0 0.00         |  0    0    0|   9
  Y 4     |    1  1 AT   9.9|  0.0 1|  0   0   0    0  0.0 11.6 1.3 12.9|  0 0.00         |  0    0    0|   9
          |                 |       |                                   |                 |             |
________________________________________________________________________________________________________

DOT COUNT:
-----------------------------------
   Meas              DBH     No.
    No.          Sp  Class   Trees
-----------------------------------
    4            BL    1        1
________________________________________________________________________________________________________

TREES MISSED / OUT:
--------------------------------------------------------------------------------------------------------
L S M Tre|-Sector-     DBH| Dia TC|- Path - | Ht   S Br Wld|CC   LC%  |  Ht   S   Sw|DmAgt1 DmAgt2 Near   Miss
Y u #  No|CsTs Ss Sp 1.3M|1.37M  |fscdbcmbr| Bk   D Tp App|  Est Msd|        t  Ln |TAg Sv TAg Sv Tree   Dr/F
--------------------------------------------------------------------------------------------------------
         |               |       |         |             |         |             |
_________|_______________|_______|_________|_____________|_________|_____________|______________________
_________|_______________|_______|_________|_____________|_________|_____________|______________________
________________________________________________________________________________________________________

REPORT No: 8                    MSRM - Terrestrial Information Branch                      Page:4
2002 Aug 14                       Reg  Comp  Let  Inst  Sample  Type
```

```
10:51:05                         55   18        0      1     G

                                                                 ______  Notes:
                                                                | Y | N |
                                                                |   |   |
     Location and Access Notes correct and easy to follow?..........|___|___|  ______________________________
                                                                |   |   |
     Tie point correct and reasonably easy to locate?...............|___|___|  ______________________________
                                                                |   |   |
     Tie line bearing and distance marked and run correctly?........|___|___|  ______________________________
                                                                |   |   |
     Plot centre plaque correctly filled in and attached?...........|___|___|  ______________________________
                                                                |   |   |
     Tree tags face correct direction and nails at correct height?..|___|___|  ______________________________
                                                                |   |   |
     Tree tag nails out sufficiently until next measurement?........|___|___|  ______________________________
                                                                |   |   |
     Plot/subplot radii checked in 3 places and no trees missed/out?|___|___|  ______________________________
                                                                |   |   |
     All ingrowth trees tagged and measured?........................|___|___|  ______________________________
                                                                |   |   |
     Other?.........................................................|___|___|  ______________________________

                                                          Rating______


     ABC Ltd.                   Andy & Barry               _______________     ____________
     Contractor                 Field Crew                 Inspecting Officer  Date
```

Appendix 16: Completing the Field Sheets

Item	Instruction
Sample ID	
Reg	Enter the region: - a provincial inventory reference number obtained from inventory maps.
Comp. No.	Enter the compartment number: - a provincial inventory reference number obtained from inventory maps.
Letter	Enter the letter (if applicable). – applies mostly in coastal areas; if the compartment letter does not exist, the field is left blank.
Instal.	Enter the installation number for **I** (Intensive) samples only.
Samp. No.	Enter the sample number: - the consecutive sample number for the compartment.
Type	Enter the type of sample: - **G** for natural stands; **R** for experimental; **T** for silviculturally treated stands; and **I** for Intensive.
Plot	Enter the plot number: - usually 1; but can be 1, 2, or 3 up to 5.
Plot Description	
Aspect	Enter the plot aspect in azimuth (0-360 degrees).
Slope	Enter the average % slope of the plot.
Elev.	Enter the elevation above sea level.
Sample Details	
Meas. No.	Enter **0** at establishment, **1** for the first remeasurement, **2** for the second, and so on.
Meas. Date	Enter the date of plot measurement (year-month-day).
Suitable for Remeas.	Enter at remeasurement: - **Y** (Yes) or **N** (No) - *(Appendix 20)*
Buffer Dist.	Buffer disturbance: - enter **Y** (Yes) if plot buffer disturbed; otherwise **N** (No).
Disturb. Dist.	Disturbance distance: - enter distance from plot perimeter to disturbance.
Centre Stake O.K.	Enter at remeasurement if centre stake moved: - **Y** (Yes) or **N** (No).
Diam. 1.3 m	Enter **Y** (Yes) if diameter is measured @ 1.3 m; otherwise enter **N** (No).
Diam. 1.37 m	Enter **Y** (Yes) if diameter is measured @ 1.37 m; otherwise enter **N** (No).
Break Pt.	Enter the break point number for tagging plot trees: - usually 4.0 cm DBH.
Diam. or Ht.	Enter **D** (Diameter) or **H** (Height) for break point criteria.
DBH Ref. Pt.	Enter **PoG** (Point of Germination) reference point for samples established before 1991.
	Enter **UpH** (Uphill side) reference point for samples established after 1990.
Stem Map	Enter **Y** (Yes) if the sample is being stem mapped; if not, enter **N** (No).
Stumps	Enter **Y** (Yes) if stumps are to be measured at establishment; otherwise **N** (No).
Selct. Logged	Enter **Y** (Yes) if the area has been selectively logged; if not enter **N** (No).
Special Site	If age and height of plot trees are not representative of Site Index, enter a corrected number.
Special Program	Enter **Y** (Yes) if the sample represents a special project.
THSS	Top Height Site Sector:- Enter **C** (Centre sector) if the top height tree(s) come from the centre sector or **A** (All) for all sectors.

Item	Instruction
Lean/Sweep	Enter **Y** (Yes) if Lean or Sweep is being recorded; otherwise **N** (No). Note: This is primarily used for **I** (Intensive) Samples.
Stand Struct.	Stand Structure: - Enter **1** for simple layer; **2** for complex; and **3** for multi-layer.
Primary Layer	Enter primary layer **1**; (**1** or **2**) if multi-layer stand structure.
Crown Closure	
Layer 1	Enter the crown closure of the plot (for layer 1) to the nearest 10%.
Layer 2	Enter the crown closure of the plot (for layer 2 if applicable) to the nearest 10%.
Layer V	Enter the crown closure of the plot for the veteran component (must be less than 6%).
Spacing Type	Enter **S** (Square) or **T** (Triangular).
Stand Damage	*(Appendix 14.)*
Compl./Partl./Blnk.	Enter the stand damage for sample: - **C** (Complete); **P** (Partial); or blank for no
Agent 1 - Year	Enter the year of damage from 1st. damage agent.
Type	Enter the code for the type of 1st. damage agent.
Severity	Enter the % severity level for 1st. damage agent.
Agent 2 - Year	Enter the year of damage from 2nd damage agent.
Type	Enter the code for type of 2nd damage agent.
Severity	Enter the % severity level for 2nd damage agent.
Slope Position	Enter the slope position for the plot: - **C** (Crest); **U** (Upper); **M** (Mid Slope); **L** (Lower); **T** (Toe); **D** (Depression); or **F** (Flat).
Plot Size	
Plot Radius	Enter the plot radius.
Plot Area	Enter the plot area.
Sub-plot Radius	Enter the sub-plot radius.
Sub-plot Area	Enter the sub-plot area.
Live Tree Measurements	
Meas. No.	Enter **0** at establishment, **1** for the first remeasurement, **2** for the second, and so on.
Layer	Enter **1** for single layer stand; **2** for second layer; and **V** for veteran layer.
Delete Tree	Enter **Y** (Yes) to delete a tree at establishment or an ingrowth at remeasurement.
Tree No.	Enter the tag number of the tree being examined.
Species	Enter the species code of the tree being examined (Appendix I4).
Centre Sector	Enter a **C** if the tree is a potential Top Height tree.
Tagging Sector No.	Enter the tagging sector number in which the tree is located.
Site Sector No.	Enter the site sector number in which the tree is located.
Tag O.K.	Enter **Y** (Yes) if original tag is on tree at remeasurement. Enter **N** (No) if tag and/ or nail is missing.
DBH @ 1.3 m	Enter the diameter at breast height to the nearest millimetre.
Crown Class	Record the crown class (**1** to **6**) of each tree.
Live Cr.	Enter the length of the live crown expressed as a percentage of the total length of the tree (to the nearest 10%; **1** = 10%, etc.).
Tree Class	Enter the correct tree class code: **1** to **6**.
Path Remarks	Record the decay indicator code present on each tree (Appendix 11).

Item	Instruction
Ht. to Break	Record the height to break for live and dead trees.
Dead Tree Measurements	*(Appendix 22.)*
Tree Cert. Code	Enter **1** for tree certainty positively identified; **2** for likely correct; and **3** for uncertain.
Sp. Cert. Code	Enter **1** for species certainty positively identified; **2** for likely correct; and **3** for uncertain.
Vert. Position	Enter **S** for free standing tree and **D** for down on the ground (including supported by other trees).
Wildlife App.	Use visual description codes **1** to **7**.
Down Position	Enter down position: **S** for supported off the ground and **D** for down on ground.
Dead Tr. Stmp.	Enter **Y** (Yes) if stump originated from cut tree.
Missed Tree	At remeasurement enter **M** if the tree was missed at previous measurement; **D** if the tree is to be dropped because it is determined to be outside of the plot; or **F** if the tree is gone and most likely dead and fallen.
Estimated Ht. (Vets) or Small Tree	Record the estimated height for veteran trees or for **I** (Intensive) samples measure the small tree height.
Sweep	Record sweep for **I** (Intensive) samples: - **1** for minor; **2** for major lean.
Lean	Record Lean for **I** (Intensive) samples: - **1** for minor; **2** for major sweep..
Other Diameter	
Stump	Enter at establishment: - **N** (New) for a stump <5 years old; **O** (old) for a stump ≥ 5 years old.
Stump diam./ or DBH @ 1.37 m	Measure diameter of the stump/ or DBH of tree if measured at 1.37 m.
Stump Ht.	Measure height of stump.
Near Tree No.	Record the tree number of the closest sequentially numbered living tree to the ingrowth; sub-plot; or dead tree being measured.
In Plot	Record **Y** (Yes) if the tree is measured outside of plot. **N** (No) is the default.
Damage Agent 1	*(Appendix 14)*
Type	Enter single letter code for damage agent 1.
Agent	Enter two letter code for detailed description.
Severity	Enter appropriate code for damage severity.
Damage Agent 2	
Type	Enter single letter code for damage agent 2.
Agent	Enter two letter code for detailed description.
Severity	Enter appropriate code for damage severity.
Ht. Suitable	Enter height suitable code: **Y** (Yes); **N** (No); **C** (Could be); **V** (Very difficult); **E** (Easy); or **F** (Flagged).
Stem Mapping	
Bearing	Record the azimuth bearing from plot centre (PC) to the tree.
Slope	Record the % slope between PC and the tree.
Slope Dist.	Record the slope distance between PC and the tree.

2nd page

Item	Instruction
Reg	Enter the region: - a provincial inventory reference number obtained from inventory maps.
Comp. No.	Enter the compartment number: - a provincial inventory reference number obtained from inventory maps.
Letter	Enter the letter (if applicable). – applies mostly in coastal areas; if the compartment letter does not exist, the field is left blank.
Instal.	Enter the installation number for **I** (Intensive) samples only.
Samp. No.	Enter the sample number: - the consecutive sample number for the compartment.
Type	Enter the type of sample: - **G** for natural stands; **R** for experimental; **T** for silviculturally treated stands; and **I** for Intensive.
Plot	Enter the plot number: - usually 1; but can be 1, 2, or 3 and up to 5.
Meas. No.	Enter **0** at establishment, **1** for the first remeasurement, **2** for the second, and so on.
Centre Sector	Enter **C** for a potential Top Height tree or SIBEC tree; otherwise leave blank.
Tag. Sector No.	Enter the tagging sector in which the tree is located.
Site Sector No.	Enter the site sector in which the tree is located.
Tree No.	Enter the tag number of the tree being examined.
Species	Enter the species code of the tree being examined.
Height Calculation	
Top	Enter the top Suunto reading (% scale).
Bottom	Enter the bottom Suunto reading (% scale, + or -).
Total	Enter the total of the top and bottom readings.
Slope Dist.	Enter the slope distance from the tree to the measurer.
Slope %	Enter % slope.
Horiz. Dist.	Enter the horizontal distance between the tree and the measurer.
Height	Enter the calculated height.
Height Correction	Enter the height correction (normally 1.3 m).
Total Height	Enter the total height.
Age Calculation	
Age Core Tkn.	Age core taken: Enter **Y** (Yes) or **N** (No).
Boring Age	Enter the boring age.
Boring Height	Enter the boring height (1.3 m).
Age Correction	Enter the age correction.
Total Age	Enter the total age.
Pith	If the pith is included, enter **Y**(Yes); if missed, enter **N** (No); and if the core has rot, enter **R** (Rotten), and if the age was taken on a similar size out of plot tree, enter **E** (estimate).
Radial Increment	
Last 5 Yrs.	Enter the radial increment for the last 5 years.
Last 10 Yrs.	Enter the radial increment for the last 10 years.
Last 20 Yrs.	Enter the radial increment for the last 20 years.
Age Suppression	*(Appendix 23)*
Suppression	Enter presence of age suppression in core: **Y** (Yes); **N** (No); or **P** (Possibly).
Core Length	Enter core length to pith.

Item	Instruction
Supp. Age	Enter number of years of suppression.
Supp. Length	Enter length of total suppression.
Supp. 10 Yrs.	Enter length of last 10 years of suppression.
Released 10 Yrs.	Enter length of first 10 years after release.
Tree In/Out of Plot	Record **Y** (Yes) if the tree is measured outside of plot; otherwise **N** (No).
Compass Offset	
Compass at PC	If compass is not at plot centre, enter **N** (No); otherwise **Y** (Yes).
Bearing From Compass to Plot Centre	Enter bearing (0-360) from the compass to plot centre.
Slope	Enter % slope from the compass to plot centre.
Slope Distance	Enter the slope distance from the compass to plot centre.
Dot Count Summary	
Meas. No.	Enter **0** at establishment, **1** for the first remeasurement, **2** for the second, and so on.
Species	Enter the species code of the tree being examined.
0.3-1.3 m (0)	Enter the number of trees ≥ 0.3 m and ≤ 1.3 m height
0.1-1.9 cm (1)	Enter the number of trees > 1.3 m and < 2.0 cm DBH.
Total	Enter the total dot count trees for each species.

Appendix 17: Location and Access Notes Example

Region 18 Comp. 8 Sample 2

Cranbrook - Proceed along Gold Creek Rd. past the Natural Gas Station to 17th Street South.

0 km - Junction of Gold Creek Rd. & 17th St. South. Proceed West on Gold Creek. Rd.

15.3 km - Gold Creek Ranch on left.

28.6 km - Bridge over Gold Creek at B.C.F.S. campsite

30.6 km - Turn left off of Gold Creek Rd.

30.7 km - Cross over creek (bridge).

30.9 km - Keep right at Y.

30.9 km - Cross pipeline - keep right.

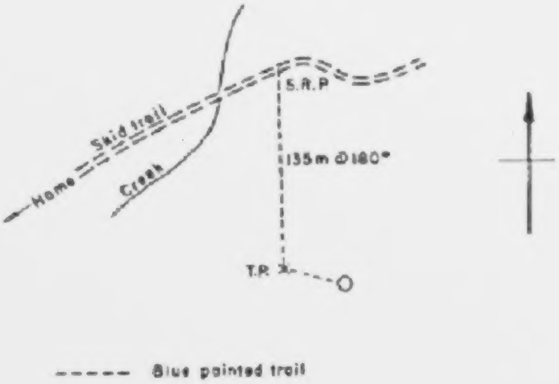
31.2 km - Driving parallel to pipeline.

31.6 km - Keep right - leave pipeline.

32.4 km - Make sharp left turn - cross pipeline and turn right.

32.6 km - Merge with road on left - keep straight.

33.4 km - Cross creek and park truck. Sample reference point is 50 m from the creek along skid trail. Tie point is 135 m at 180° from sample reference point.

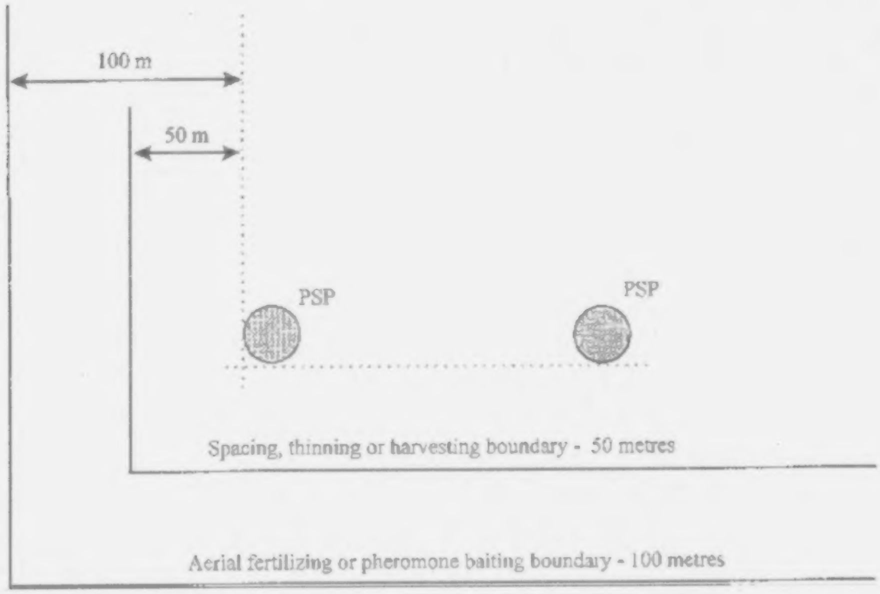


Appendix 18: Recommended Protection Buffers for Permanent Samples

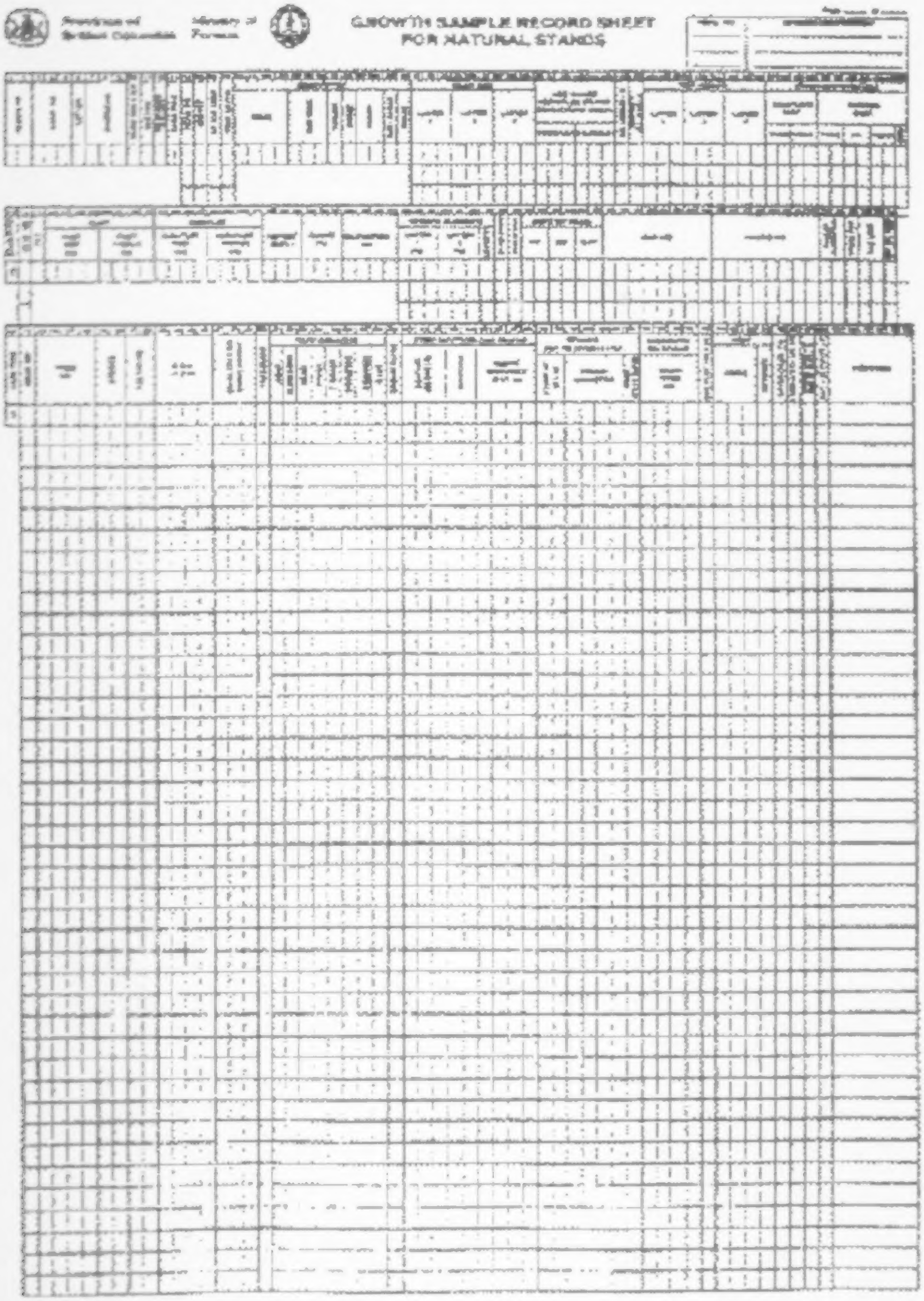
Hypothetical Permanent Sample Plots (PSP) showing buffer zones required for operational spacing, thinning, harvesting and fertilizing.

These buffers may be reduced with documented rationale but must be at least 20 metres or Top Height, whichever is greater.

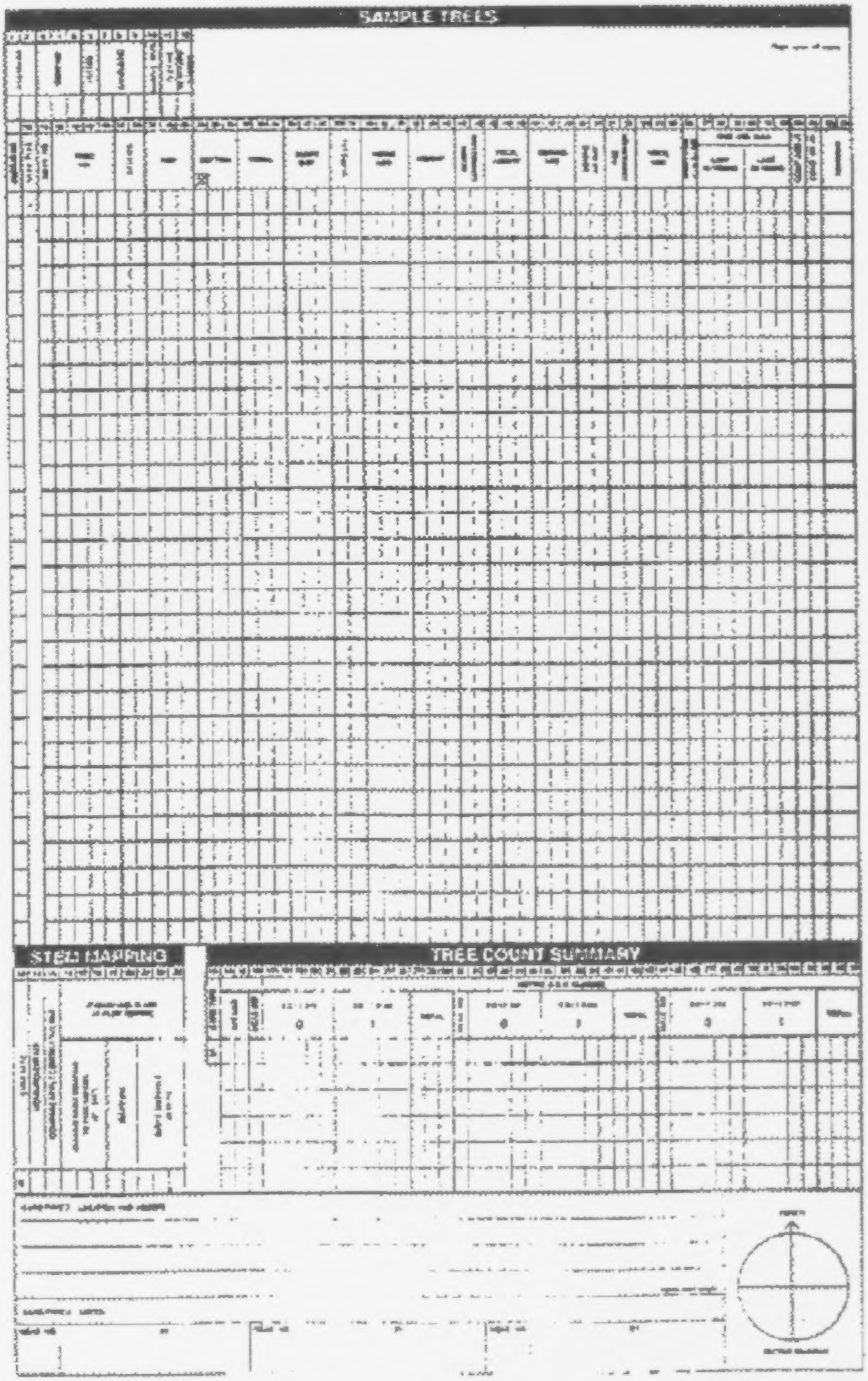
The person responsible must take into consideration the nature of the silvicultural treatment (up-slope or up-wind aerial application of fertilizer) or the susceptibility to windthrow.


100 m
50 m
PSP
PSP
Spacing, thinning or harvesting boundary - 50 metres
Aerial fertilizing or pheromone baiting boundary - 100 metres

Appendix 19: Growth Sample Record Sheet



GROWTH SAMPLE RECORD SHEET
FOR NATURAL STANDS



SAMPLE TREES

STEM MAPPING

TREE COUNT SUMMARY

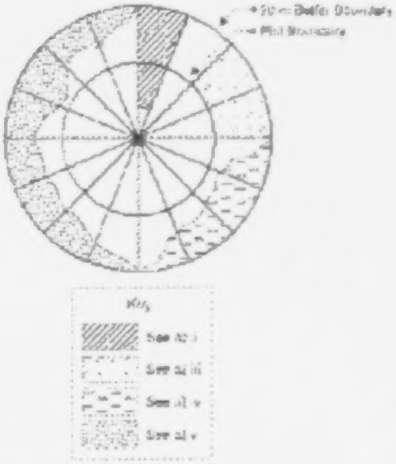
Appendix 20: Guidelines for Deciding if Damaged Permanent Plots Should be Remeasured

To decide if a damaged plot should be remeasured, the source of the damage must be considered.

1. If the damage is the result of natural causes such as slides, fungi, insects, disease and fire, it should be remeasured if at least 25% for the plot trees are still living.

2. If the damage is the result of human activities, it must be considered in one of two ways:

    a) **Major disturbance** (i.e., harvesting, road building, hydro right of way, etc.) remeasure if:



        i. the disturbance is outside the 20 metre buffer.

        ii. the 20 meter buffer is destroyed over an area less than 1/16th of the plot circumference and less than 5% of the plot trees are destroyed.

        iii. the 20 meter buffer is destroyed but only over an area less than 1/8th of the plot circumference and none of the plot trees are destroyed.

        iv. The 20 meter buffer is 75% destroyed but only over an area less than 1/4 of the plot circumference and none of the plot trees are destroyed.

        v. the 20 meter buffer is 50% destroyed but only over an area less than 1/2 of the plot circumference and none of the plot trees are destroyed.

    b) **Minor disturbance** (i.e., spacing, pruning, firewood cutting, small trails, etc.) remeasure if:

        i. less than 10% of the plot trees are destroyed, and

        ii. less than 10% of the sample area is destroyed, and

        iii. the disturbance is not localized (no more than 5% of crown closure in one spot).

Appendix 21: Converting Breast Height in Industrial Permanent Samples

Convert all industrial permanent sample plots (PSPs) from imperial (1.37 m) to metric (1.3 m) breast height. The conversion is done once to give a base-year measurement.

For all commercial and non-commercial trees 4 cm d.b.h. and greater in the plot and commercial trees 2 cm d.b.h. and greater in the sub-plot, measure the diameters at 1.3 m and at 1.37 m above the germination point. Measure all of the originally tagged trees, including those that died since the last measurement or were cut down as well as ingrowth plot and sub-plot trees.

To convert, use only one of the two methods described below. The first is the preferred one.

Method 1

For trees tagged originally:

1. Make sure the tree number tags are nailed to each tree 1.37 m above the germination point.
2. If necessary, replace the nail and tag. The new tag must have the same number as the old one. Make sure the nail is out far enough to allow for future growth.
3. Drive a second nail at 1.3 m (0.07 m below the nail at 1.37 m).
4. Measure both diameters above the nail.

Method 2

For trees tagged originally:

1. Measure the diameter at 1.37 m above the germination point.
2. Mark the metric breast height at 1.3 m (0.07 m below the nail at 1.37 m).
3. Move the nail and tag to the 1.3 m mark. If necessary, replace the nail and tag with a new tag with the same number.
4. Measure the diameter at 1.3 m.

For trees not previously tagged—example, ingrowth and sub-plot trees:

1. Mark the breast heights at 1.3 m and 1.37 m above the germination point.
2. Nail the tag at 1.3 m.
3. Measure the diameters at 1.3 m and at 1.37 m.

Establishing a Sub-plot in Industrial Plots

If a sub-plot is not already established, you must establish one at plot center to have some representation from trees below the tagging limit, that is, trees less than 4 cm d.b.h.

In a square or rectangular experimental plot, the sub-plot center is identified by an aluminum tubular stake driven into the ground where the two diagonal lines from the corner posts intersect.

When you establish a sub-plot, the perimeter must not extend beyond the plot boundary. The objective in each sub-sample is to obtain a minimum of 20 commercial trees that are less than 4 cm d.b.h. but are at least 0.3 m high. The sub-sample size depends on stand density. See Appendix 6 for a list of sub-plot radii.

1. Choose the sub-sample size and mark the sub-plot circumference with string.
2. Within the sub-plot, tag all living commercial trees with a d.b.h. of 2 cm and greater, but under 4 cm at 1.3 m and 1.37 m above germination using methods 1 or 2 above.

For the trees in the sub-plot with a d.b.h. of less than 2 cm:

1. Count the trees in a dot tally.
2. Derive their metric d.b.h. classes—either d.b.h. class 0 or 1. See "Table 1 below".

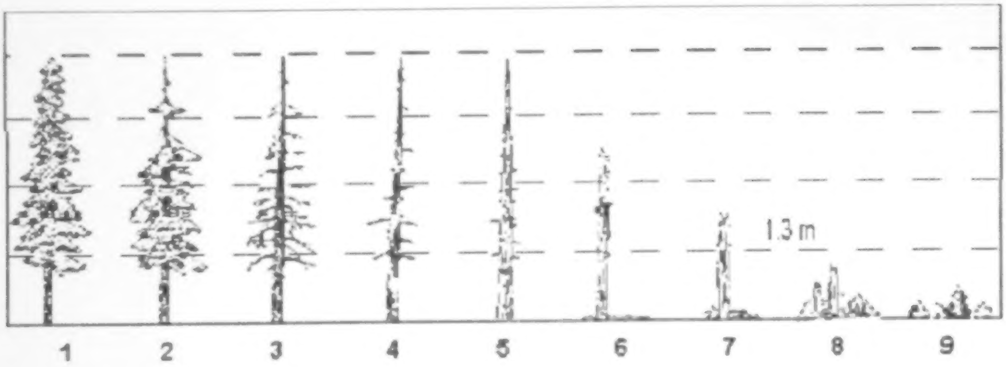
Table 1 Metric d.b.h. Classes and Limits

d.b.h. class	Limits
0	0.3 m to 1.3 m high
1	0.1 cm to 1.9 cm d.b.h.

Appendix 22: Dead Tree Attributes

For each dead tree that is ≥10.0 cm in d.b.h. and ≥1.3 meters in height, collect the following attributes if, the tree is standing - both at establishment and remeasurement - or down if it was living at the last measurement:

- Number
- Number certainty
  - positively identified (1)
  - likely correct (2)
  - uncertain (3)
- Species
- Species certainty
  - positively identified (1)
  - likely correct (2)
  - uncertain (3)
- Diameter at 1.3 meters
- Tagging sector
- Near tree number
- Tree class
- Vertical position
  - standing (S)
  - down (D)
    - supported (S)
    - on ground (G)
- Broken and standing
  - yes (Y)
  - no (N)
- Height to break (ocular estimate to the nearest meter)
- Damage agent code and Severity (see Appendix 14)
- Wildlife tree appearance as follows: Use codes (1) to (7).


1.3 m

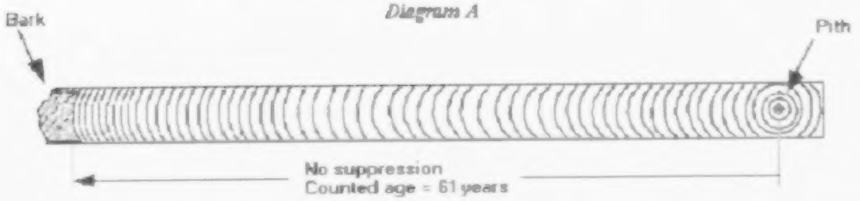
Appendix 23: Field Assessment of Suppressed Trees

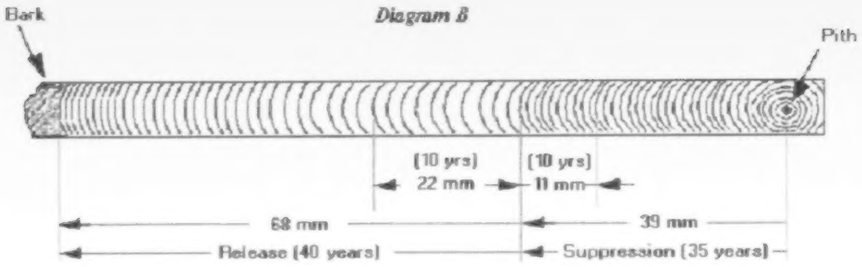
Suppression Ratio is defined as the ratio of the mean annual growth increment after release divided by the mean growth of the preceding period of suppressed growth.

- the period of time will be 10 to 20 years in determining the ratio. The maximum period shall be no longer than 20. Unequal periods of suppressed and released growth can be compared as long as mean annual growth is the variable used.
- reduced ring growth near the bark (after a period with larger rings) will be considered normal
  (see Diagram "A").
- suppression is only recorded when the ratio of released to suppressed interval is 2 times or more.
- suppression can occur more than once in a tree's life and the same criteria will be used to determine suppression on each occasion. Two or more periods of suppression can be averaged to determine the mean ratio.
- field measurements required to determine suppression are: total breast height age (to pith); core length (to pith); suppressed age; suppressed length; and 10 year increment of suppressed and released growth. If the period of suppression or released growth is less than 10 years, use an equivalent period based on the lower of the two. This shorter period should be at least five years.

e.g. Diagram "B"	*total BH age (pith)*	***75 years***
	core length	***107 mm***
	suppressed age	***35 years***
	suppressed length	***39 mm***
	10 yr. suppressed length	***11 mm***
	10 yr. released length	***22 mm***

Diagram A

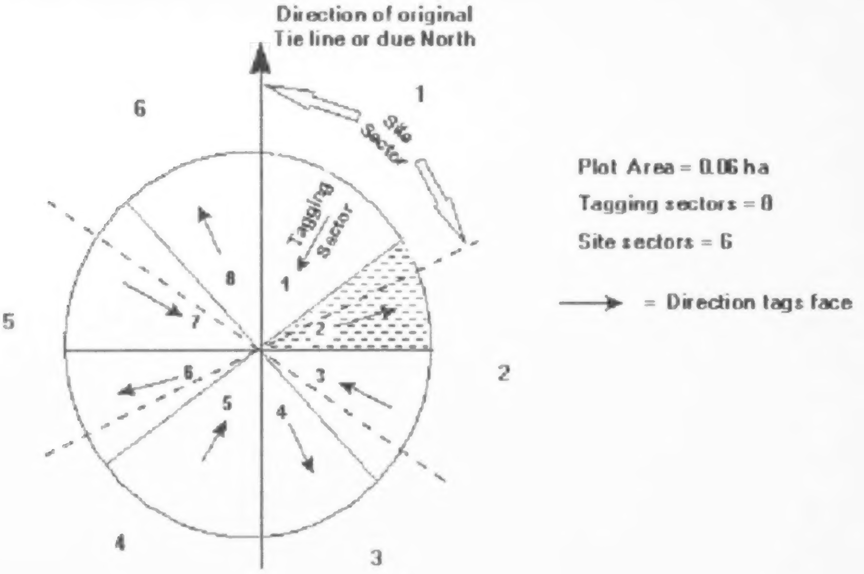


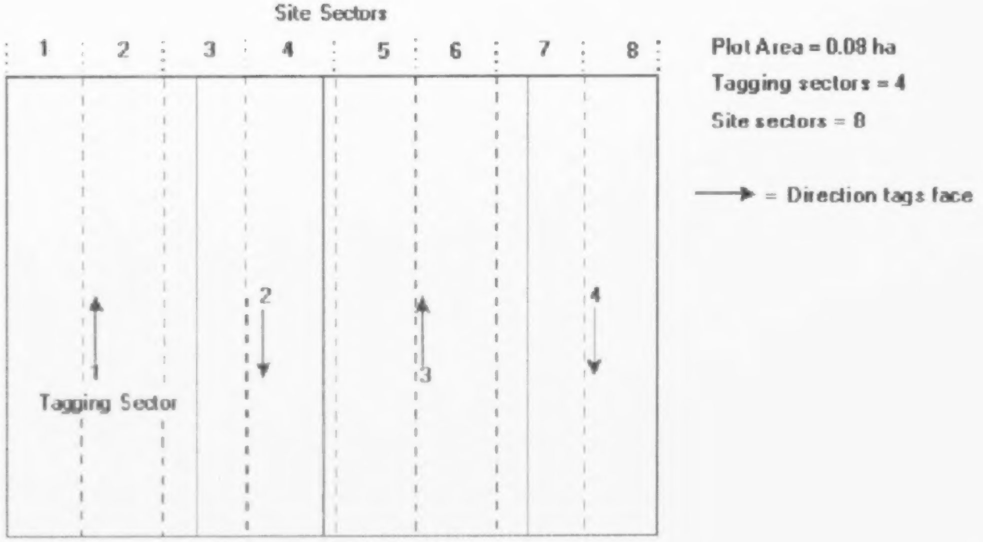

Bark
Diagram B
Pith
(10 yrs)
22 mm
(10 yrs)
11 mm
68 mm
39 mm
Release (40 years)
Suppression (35 years)

In this example, the field data used in the calculation of suppression ratio is:

(22 mm/10yr) / (11 mm/10yr) = 2

Appendix 24: Example of Tagging and Site Sectors for Remeasuring Plots


Direction of original
Tie line or due North
Site Sector
Tagging Sector
1
2
3
4
5
6
1
2
3
4
5
6
7
8
Plot Area = 0.06 ha
Tagging sectors = 8
Site sectors = 6
= Direction tags face


Site Sectors
1
2
3
4
5
6
7
8
1
2
3
4
Tagging Sector
Plot Area = 0.08 ha
Tagging sectors = 4
Site sectors = 8
= Direction tags face

Appendix 25: Minimum Data Collection Requirements for Ecological Field Forms (FS 882)

Site Form

1. Date (Y/D/M)
2. Plot number
3. Surveyor(s)
4. General location
5. Forest region
6. Mapsheet
7. UTM (zone, easting and northing) or latitude and longitude
8. Site diagram
9. Plot representing
10. Biogeoclimatic unit
11. Site series
12. Transition/Distribution
13. Moisture regime
14. Nutrient regime
15. Successional status
16. Structural stage
17. Site disturbance
18. Elevation
19. Slope
20. Aspect
21. Meso slope position
22. Surface topography
23. Exposure type (if applicable)
24. Surface substrates (organic matter, decaying wood, bedrock, rocks, mineral soil, water)

Soil Form

1. Plot number
2. Surveyor(s)
3. Bedrock (at least to general level, where significant to site)
4. Coarse fragment lithology (at least to general level)
5. Terrain texture, surficial material, surface expression
6. Soil classification (to subgroup)
7. Humus classification (at least to group)
8. Hydrogeomorphic unit (at least to system)
9. Rooting depth
10. Rooting zone particle size
11. Root restricting type and depth (if applicable)
12. Water source (if applicable)
13. Seepage depth (if applicable)
14. Soil drainage
15. Flooding regime (if applicable)
16. Organic horizons/layers; for each: horizon/layer code depth
    - mycelial abundance
    - fecal abundance
    - von Post (for organic soils)
17. Mineral horizons/layers; for each: horizon/layer code
    - depth
    - colour (when required for diagnostic purposes)
    - colour aspect (when colour entered)
    - soil texture (< 2 mm fraction)
    - % coarse fragments (gravel, cobbles, stones, and total)
    - comments (especially mottles)
18. Profile diagram
19. Notes

Vegetation Form

1. Surveyor(s)
2. Plot Number
3. % cover by layer (A, B, C, D)
4. Species by layer
5. Cover for each species by layer and sublayers
6. Note

B.C. Ministry of Forests, Research Branch, 1999